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The magazine may be either machined out of the front end of the primer itself, as in the No. 1 type, or take the form of a separate container screwed into the body of the primer as in the No. 2.

A further feature is the ball seal, which functions in a chamber formed between the anvil and a perforated plug or washer separating it from the magazine.

This is only essential for such primers as may be used with Q.F. guns in which the pressures are high or sustained. Thus, in the No. 1 Mark II primer, a ball seal is used to ensure effective sealing. Among the smaller primers, it is used in the Marks IV and VII patterns of the No. 2, as an additional but not an essential safeguard, for which room cannot be provided in the Mark III pattern, the cap itself being sufficiently strong to seal escape of gas through the body.

§4.04. Markings on primers.

Primers are stamped on the head with the following markings (*see* Fig. 4.07) :—

- (i) Number and Mark of primer.
- (ii) Manufacturer's initials or recognized trade mark.
- (iii) Acceptance mark (after filling).
- (iv) Filler's initials or recognized trade mark.
- (v) Date of filling (month and year).
- (vi) Lot number.
- (vii) " M " indicates repair and refilling.
- (viii) Workmarks.

§4.05. Primer, percussion, Q.F. cartridge, No. 1, Mark II.

The *body* of the primer is of brass, Class A or B, and is formed with a flanged head, in which two slots for the key are cut.

A portion of the body is screw-threaded externally to screw into the base of the cartridge.

The percussion and igniting arrangements in the body consist of the cap, anvil and magazine.

The *copper cap* is coated with R.D. cement, prior to insertion in the body, to seal the joint in the cap seating.

The brass *anvil* is screwed home on to the cap.

The copper ball is inserted and held in position by the brass closing plug, which is screwed home after it.

A fine white paper capsule or disc is then secured over the internal boss of the primer.

The magazine is filled with G.12 powder, and is closed by a brass closing disc, to the inner face of which a paper disc is shellaced.

Six radial slits are cut in the closing disc, so that on firing the cut portions of the disc open outwards, the disc itself being held in by the mouth of the primer which is turned over on to it.

As a protection against damp, R.D. cement is applied between

Fig 4·05.

PRIMER, PERCUSSION, Q.F. CARTRIDGES, No. 1 Mk. II | C |.

Scale – 2/1.

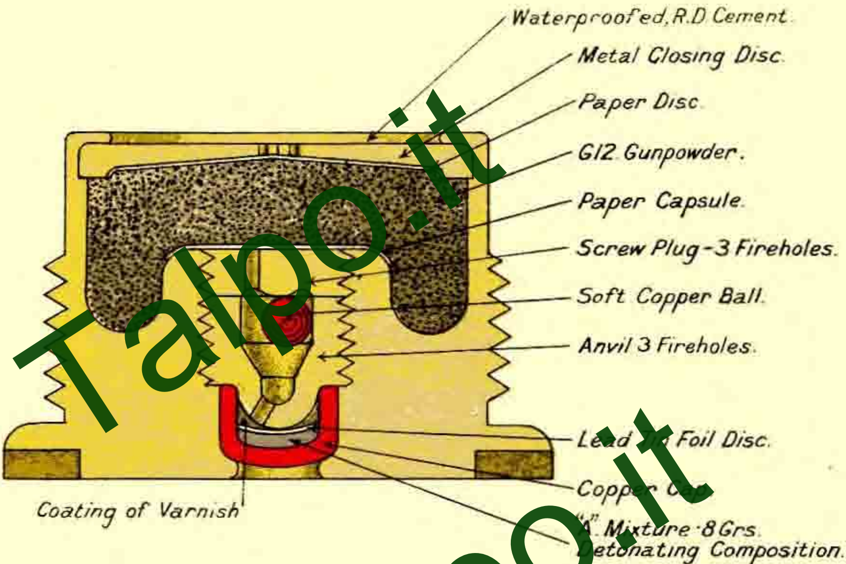


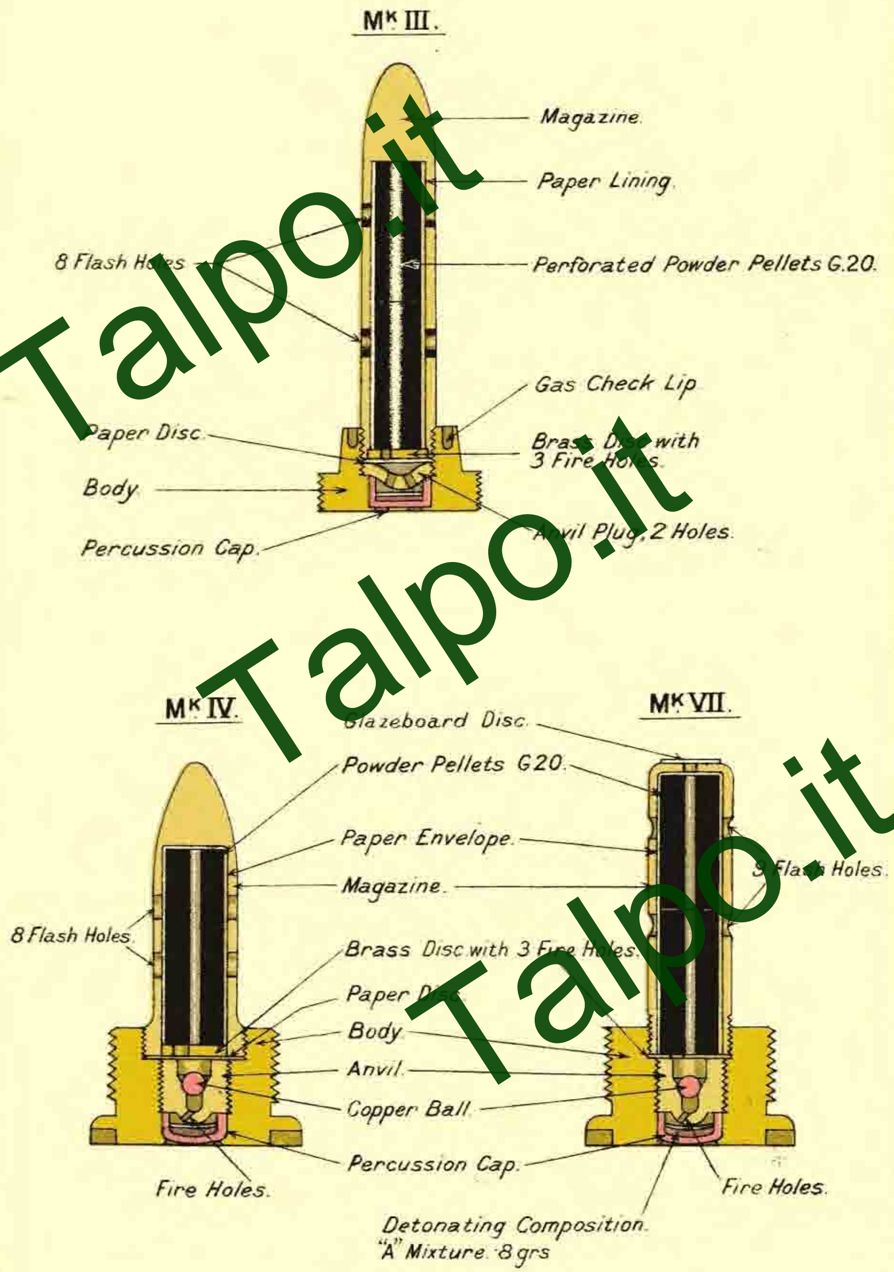
Fig 4·05(a).

PRIMER, PERCUSSION Q.F. BLANK 6 or 3 Pr Mk. III | L |.

Scale 2/1.

Fig. 4·06.

PRIMER, PERCUSSION, Q.F. CARTRIDGE No 2.



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the body and the cap, to the outside of the closing disc, and to the joint between the closing disc and the body of the primer.

Action.—The cap is fired by a blow of the striker ; the flash from the cap fires the powder in the magazine, and this in turn ignites the propellant charge.

The copper ball is blown back into its coned seating in the anvil by the pressure of the propellant gases, thus sealing the escape rearwards through the primer.

Refilling of primers.—If considered suitable, No. 1, Mark II primers may be modified and refilled. They will be distinguished by the letter " M " added to the Mark.

Packing.—Primers No. 1 are packed either 4 in a tinned plate box or 10 in a tinned plate cylinder.

Both packages are painted black and the ground colour of the label is white.

§4.06. Primers, percussion, Q.F. cartridge, No. 2.

There are three marks of this primer in use with Q.F. 3-pr. and 6-pr. ammunition, viz. Marks III, IV and VII.

Marks IV and VII are used with the latest marks of cartridge cases, which are designed for them.

The Mark III primer was designed for the older marks of cases which were originally capped, but have been converted to take primers.

It will be observed that the magazine containing a perforated pellet of R.P. or G 20 powder is cylindrical, and is screwed into the body of the primer.

A number of holes are drilled radially in the cylinder.

In the Mark III the *head* of the primer is screw-threaded, and a gas-check is formed on the front end of the body. There is no copper ball.

In the Marks IV and VII the *body* of the primer is screw-threaded and is stronger in construction than the Mark III. A copper ball is provided to seal the escape of gases through the primer.

The Mark VII is the latest type. It is similar to the Mark IV, except for small manufacturing details.

Refilling.—If considered suitable, the Mark VII primers may be modified and refilled. They will then be distinguished by having the letter " M " added to the Mark.

Packing.—Mark III, 20 in a cylinder. Marks IV and VII, 10 in a cylinder.

§4.07. Primer, percussion, Q.F. cartridge No. 11, Mark I.

This primer is similar to the primer No. 1, Mark II, except that it is longer and is provided with a screwed-in magazine.

The magazine is formed from cupped brass, threaded at the mouth to engage with the threads formed in the body. It has eight holes drilled radially to form flash holes and one through the nose to receive a white metal dome, which is secured to the magazine by riveting.

To the interior of the magazine an envelope of white fine paper is secured with shellac varnish; the charge is about 6 drams of G.12 gunpowder.

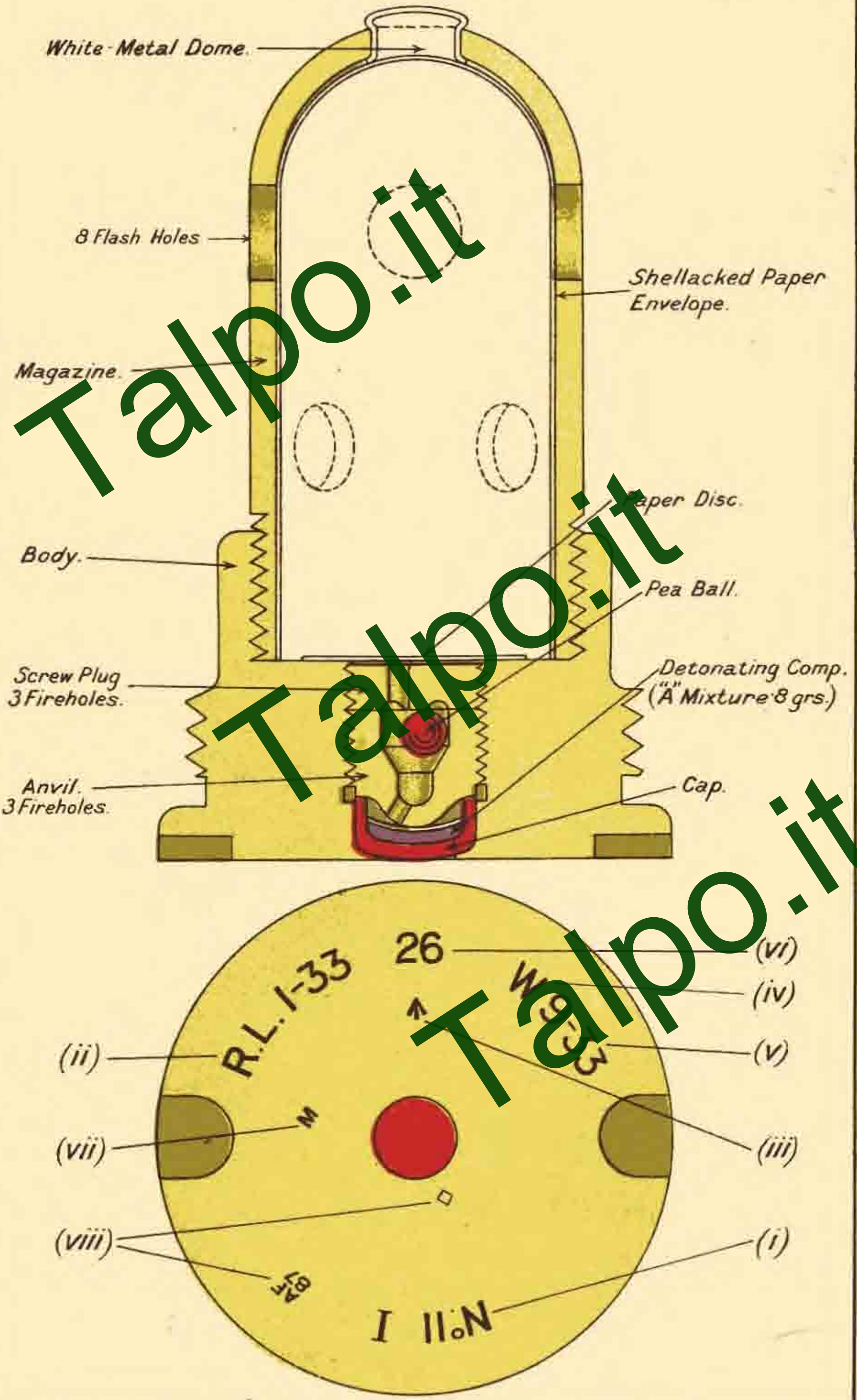
A disc of white fine paper is secured with shellac varnish over the lighting holes in the body.

Uses.—This primer is at present for use with certain propellants, but may eventually supersede the primer No. 1.

Fig. 4.07.

PRIMER PERCUSSION, Q.F. CARTRIDGE No. 11 Mk. I/L/.

Scale - 2/1.



Company and is generally known as the E.O.C. band. It has been adopted for use with high velocity B.L. 5·5-inch and 4-inch guns.

G.5.—This is a design of band at present applied to naval service 4·7-inch and 5·2-inch guns. It is a hump band of simplified contour, easy to manufacture, and sturdy.

G.6 was introduced for land service B.L. 60-pr. and Q.F. 4·7-inch guns. It is a simple strong design, suitable for conditions of field service.

G.7 is a plain cannelured band, not unlike the original Vavasseur. It is used for certain naval fixed ammunition guns. It has a tendency to rear fanning, which will be eradicated when certain contemplated alterations are applied.

6-inch 26-cwt. 60-pr.

FIG. 5.10 (*e*)

G.8.—This is the Q.F. 18-pr. band. It is provided with a raised cartridge stop in rear. The profile is plain, and similar bands, some with and some without the case stop, are used in all lower calibres.

Economy Bands (*see* Fig. 5.10(*e*)).—Owing to the shortage of copper during the Great War, so-called "economy" driving bands were fitted on some shell, chiefly those used with B.L. 60-pr. guns and the B.L. 6-inch and Q.F. 4·5-inch howitzers. These bands were made considerably narrower than the service band in order to economize copper, but the diameter was slightly increased to prolong the life of the gun by giving better sealing effect and to decrease the loss of velocity due to over-ramming. There was

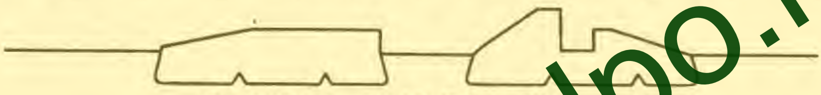


FIG. 5.10 (*f*).—Double Driving Band.

considerable saving of copper and of the life of the gun, but accuracy was affected in some cases by unsteadiness in flight due to the narrow band causing the shell to be badly centred, and to fanning.

Since the war a return has been made to the former type of band in the case of the B.L. 60-pr. and 6-inch howitzer projectiles.

Double driving bands.—These are now being introduced on 8-inch and 6-inch natures of shell. Fig. 5.10(*f*) is a typical design. The 6-inch band for naval service is of cupro-nickel, but for land service it is of copper.

This type of band was introduced to meet the mechanical difficulties of pressing a very wide single band on shell.

Double driving bands, in which the forward band is situated near the shoulder of the shell, have been proposed and tried for specially long-range projectiles, the object being to give greater steadiness to projectiles during the passage of the bore.

Augmenting strips and rings.—The augmenting strip was originally introduced in the days of powder charges to prevent over-ram in worn guns. On the introduction of cordite charges its use was extended to act as a gas-check. It consisted of a strip of pure copper of even section and grooved on one side.

The strip was placed in the cannelure grooved side downwards and hammered round the shell until the two ends met, the cannelures on the Vavasseur bands being undercut to take the strip if necessary.

Scale $\frac{1}{1}$.

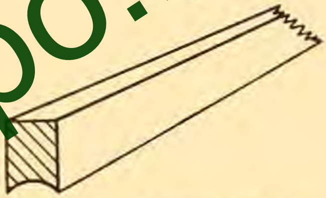


Fig. 5.10 (*g*).—Augmenting Strip.

During the Great War a different type of strip was introduced for use with 12-inch howitzer H.E. projectiles. As modern cannelures are not undercut, the strip was retained in the cannelure by means of eight inclined grooves formed alternately at equal distances on the sides of the strip when fitted in the groove. For future manufacture the strip will be formed in the band, *i.e.*, there will be no forward cannelure, but a slight hump.

The augmenting ring is intended to provide more copper for use in a worn gun. It used to be slipped over the base of the shell and seated in the recess under the gas-check.

§5.11. Shape of projectile—internal.

Although the external contour of a shell is more or less determined by the requirements of external ballistics, the strength of a shell is governed by internal design and the quality of the material specified. Besides the obvious requirement that a shell should arrive at its objective intact, strength is of the greatest importance with shell to provide against the danger of premature explosion in the gun, especially when filled with H.E.

Armour-piercing shell have to resist the severe shock of impact with a steel armour plate, and are therefore made so as to offer the maximum possible resistance to break-up. It is clear that the steel of the projectile should be so distributed that it is employed with the greatest efficiency as regards strength.

Fig. 5·11.

SHELL, B.L., A.P., WITH CAP, 9·2 INCH GUN, MK XII B|L.

SCALE – 1/4.

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Internal design of head.—The usual practice is that the wall in the head follows the external contour, keeping approximately the same thickness of metal as at the shoulder. The metal is sometimes slightly thickened towards the fuze-hole in order to allow sufficient depth to take the fuze, etc. The head thus forms a naturally strong structure which is unlikely to fail on penetration of earthworks, etc.

As already mentioned, A.P. and semi-A.P. shell have specially strengthened heads which are hardened and in the former case are practically solid. The projectile will, on arrival at the target, be submitted to crushing forces acting in the opposite direction to those set up on firing, and a shell should be of such strength that it does not break up on impact, but bursts as a result of explosion initiated by the fuze.

Base Adapters.—Base adapters are fitted to the majority of base-fuzed shell. They were introduced in order to give an aperture of increased diameter to facilitate manufacture. They also facilitate the insertion of the container and the filling of the shell. Their sizes generally approximate to the full bore of the cavity. In some cases they may obviate distortion of the fuze and exploder system at plate perforation (*see* Fig. 5.11). Base adapters have been used with H.E. nose-fuzed shell to facilitate manufacture, but the manufacture of such shell has been discontinued in peace time; a disadvantage of these shell is the difficulty of sealing the joint.

Base adapters are turned with a flange and are screwed externally to fit the shell, the plain part in front of the thread having a reduced diameter to accommodate the container, and they are bored and screwed internally to take the fuze. The length of the external thread on the adapter is determined by similar conditions to those governing the strength of the base of the shell, but the thread and flange must also be of sufficient strength to withstand the impact of the projectile on the plate without allowing the adapter to set forward under stress of its weight and that of the fuze.

(*See* Appendices for the formulæ that have been used in connection with the attack of armour.)

Fuze Sockets.—Shrapnel shell invariably have sockets, which are made either of metal or steel.

Fuze-hole bushes.—In certain cases these are permitted as an alternative to the solid head in H.E. shell. They are made of steel; metal was permissible at one time, but its use is now discontinued.

§5.12. Capped shell.

Caps of steel (*see* Figs. 5.20(*b*) and 5.08(*b*)), fixed over and attached firmly to the head of the projectile, have been introduced for armour-piercing (A.P.) and common pointed (C.P.) shell for use against armour.

To perforate an armour plate, a shell has to punch its way through the thin hard face and the thick and tough supporting back.

The object of the cap is to hold the head together at the moment it meets the hard face, and so cushion the blow which tends to shatter the point of the projectile, and there is consequently less tendency for the point itself to be broken or crushed. In a certain type of cap the forward portion of the cap itself is hardened. This penetrates the hard face of the armour and thus opens the way for the real point, so further increasing the penetrating power of the shell. With a high striking velocity, at normal impact, the cap is found to add materially to the penetrating power of the shell against a cemented plate, but the relative assistance given by the cap to the shell decreases as the striking velocity drops, and at low velocities, say under 1,000 f/s, becomes inappreciable.

There are various ways of attaching penetrative caps to shell :—

(*a*) By cotter pins. Tapered holes are formed in the head of the shell and cap, into which are driven cotter pins.

(*b*) By notching the cap into indents made in the head of the shell, usually about six.

(*c*) By pressing or rolling the cap whilst hot into an annular groove.

(*d*) By interrupted raised ribs on shell and in cap.

(*e*) By tinning the cap and the head of the shell at a temperature of about 450° F., sweating them together, finally notching the skirt of the cap into indents of the shell.

Methods (*a*), (*c*) and (*d*) are not now employed.

§5.13. Shell for use in guns and howitzers.

Though guns and howitzers of the same calibre do not as a rule fire shell of the same weight, projectiles can be designed for use in both types of ordnance, provided the difference in chamber pressure and in the twist of the rifling is taken into account.

Where both a gun and howitzer of the same calibre exist, the words " GUN," " HOW.," or " GUN and HOW." are marked clearly on the shell.

Heavy and Light Shell.

Certain guns and howitzers are issued with " heavy " and " light " projectiles. They are distinguished by the letters " H " and " L " stamped on the base and stencilled on the shoulder after the numeral of the shell.

§5.14. Manufacture of shell.

The manufacture of shell does not differ in general principle in the various types. The normal method is by forging from steel ingot or bar, though in certain cases such as practice and smoke shell the shell are cast direct to the required shape.

The steel is manufactured by the acid open-hearth or electric furnace processes, though for gun shell below 6-inch calibre and all howitzer shell, the basic open-hearth process may be used.

The steel is top-poured into ingot moulds, after which the upper end of the ingot (about 25 per cent. by weight) is removed to get rid of piping. The fracture is then examined.

All casts and ingots are numbered. Each cast is analysed. The ingots are then issued. If more than one shell is to be made from the same ingot, the ingots are rolled to their approximate section, and are fractured into their required lengths. The following procedure is then carried out on the ingot or billet :—

(1) Forged hollow by punching or drawing, limiting temperature 1,150° C. The base of the ingot must form the base of the shell, except with piercing shell where it forms the head.
(2) Forgings gauged and examined for flaws. One per cent. of forgings are tested for mechanical properties.
(3) Surplus metal at the open end cut off, leaving the shell a definite length.
(4) Base centred concentrically with interior cavity.
(5) Turned on the exterior to plan dimensions.
(6) Cavity bored out and the length of the shell corrected if necessary. Shrapnel shell are only machined inside where the tin-cup and disc fit into the cavity.
(7) Base faced and open end tapered.
(8) Bottling. The open end is heated and closed in under a press.
(9) Mouth faced and fuze-hole bored.
(10) Radius turning of head.
(11) Thread of fuze-hole cut.
(12) Weight adjusted by removing metal from the base.
(13) Groove for driving band formed.
(14) With H.E. shell, the base is recessed for base-plate.
(15) Cavity cleaned by sand blast.
(16) Preliminary examination.
(17) Driving band pressed on.
(18) Machining of driving band to plan dimensions.
(19) With H.E. shell, base-plate fitted, caulked, or riveted.

Note.—Base plates of H.E. shell are made of material in which the grain runs parallel to the face of the plate, that is, at right angles to the axis of the shell.

(20) Base plate faced flush.
(21) Cavity again sand blasted and varnished with copal varnish.
(22) Shell stoved at 300° F. to dry the varnish thoroughly.
(23) Shell stamped and greased outside.
(24) Examination and proof.
(25) Shell painted.

TYPES OF PROJECTILES

§5.15. Practice shot.

Used for practice over sea ranges. These projectiles are usually solid cast-iron of the same weight as the service projectile. A steel flat-headed practice shot with tracer has been introduced for tank practice from the 3-pr. 2-cwt. gun over land ranges.

§5.16. Proof shot.

For the proof of guns, howitzers, and charges. They are made of forged steel of the same weight as the corresponding service projectile, and are cylindrical in shape and flat-headed, so that they shall not penetrate too far into the butt.

§5.17. Paper shot.

These are used to test the mountings of guns, which cannot, owing to their position, fire service projectiles in time of peace. They are designed to cause the same amount of recoil as a service projectile and to break up in the bore. The body is made of wood pulp or rolled brown paper, and is filled to the correct weight with small shot and sawdust.

§5.18. Case shot.

These generally consist of three or more long steel segments held in position inside a thin tinned-plate canister, the whole being filled with bullets. The top and bottom are formed of steel plates, over which the serrated edge of the canister is turned. In the larger natures the shot is strengthened by a central bolt. The object of this construction is to facilitate the shot breaking up on leaving the muzzle, allowing the bullets to scatter.

§5.19. Common pointed (C.P.) and common pointed capped (C.P.C.) shell.

General design.—These shell are designed for the attack of lightly armoured vessels, concrete emplacements, dug-outs, etc., and are not intended to penetrate thick armour. They are made of forged steel, and are usually about 3·5 to 4 calibres in length. The walls are thicker than those of nose-fuzed H.E. shell, in order to enable the shell to hold together on the shock of impact and to penetrate before bursting. The thickness at the point is not much greater than that of the walls, as the main consideration in design is to give as large a bursting charge as possible, and therefore a large capacity, though latterly the tendency has been to make the head slightly more solid.

C.P.C. shell were used in the larger calibres, 6-inch and above, and these shell have hardened points which increase their penetrating power.

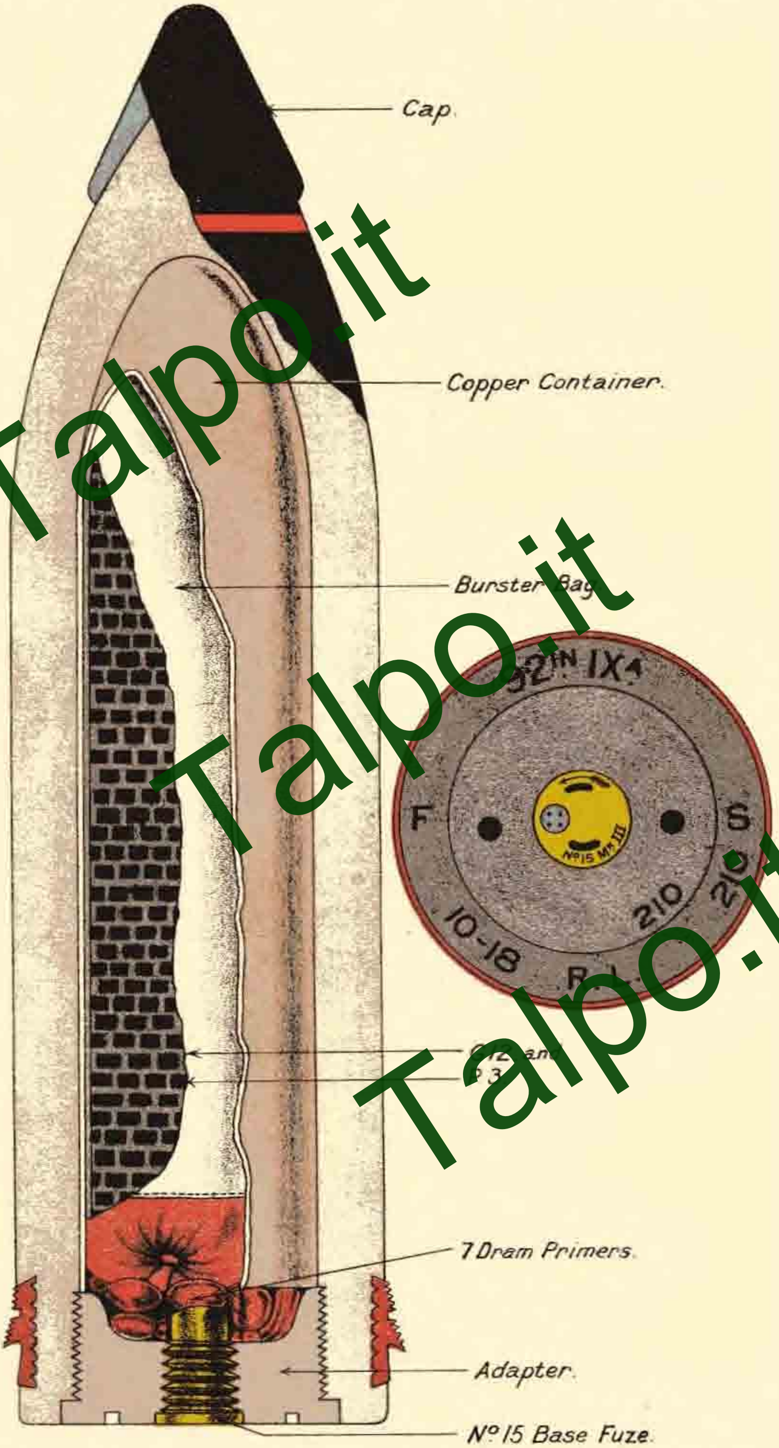
Fig 5·19 (a).

METHOD OF FILLING:- SHELL Q.F. COMMON POINTED 12 PR NON-BURSTER BAG TYPE.

R.L. 25755.

Fig. 5. 19 (b).

COMMON POINTED SHELL WITH CAP FILLED POWDER.



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Shell with hardened points are liable to spontaneous cracks. They are therefore subjected to a keeping trial in the open to allow latent cracks to develop after hardening and before final acceptance.

Filling of C.P. and C.P.C. shell.—C.P. and C.P.C. shell may be filled either with gunpowder or H.E.

In the case of gunpowder fillings, with C.P. above 12-pr., the

FIG. 5.17.—Paper Shot.

powder bursting charge is enclosed in a dowlas bag, the neck being made of shalloon to facilitate ignition, as shalloon is more permeable to flash. The base of the shell is packed with primers filled powder to make a compact filling and facilitate ignition by the fuze. C.P.C. shell are lined with copper containers to prevent accidental prematures through spontaneous cracking of the head. C.P. shell 12-pr.

and below differ from the remainder in that there is no dowlas bag, the powder being poured straight into the shell and there are no primers.

C.P. shell are coated internally with a special paint, "velvril," in order to prevent friction between any loose powder and the walls, causing a premature. For a similar reason the inside of the copper container in a C.P.C. shell is varnished.

The nature of the powder used for filling C.P. and C.P.C. shell is :—

Q.F. up to 6-pr.	G.12.
Q.F. 12-pr. and above	P.3 and G.12.
Primers are filled with	G.12.

In the case of H.E. fillings except C.P., the shell are fitted with an aluminium container, the interior of which is coated with copal varnish.

The 6-in. C.P.B.C. is filled with a mixture of trotyl and beeswax in the proportion of 93 to 7, a block of R.D. composition 1006 being first inserted into the apex of the container.

A cavity lined with a paper tube is formed in the filling to receive the exploder system consisting of two $2\frac{3}{4}$-oz. pellets of trotyl. Fig. 5.20 (*c*), showing filling of 9·2-in. A.P.C., is almost identical with 6-in. C.P.B.C., except that the trotyl surround is omitted.

Closing the bases of C.P. and C.P.C. shell.

(*a*) C.P. shell are screwed internally to take the fuze or plug, and in some cases a steel bush is fitted.

(*b*) C.P.C. shell are fitted with a base adapter, large enough for the copper or aluminium container to be inserted.

NOTE.—C.P. shell filled powder or H.E. do not have containers, as the points are not hard.

The closing of the base of a C.P. or C.P.B.C. filled H.E. is similar to that of an A.P. shell filled H.E.

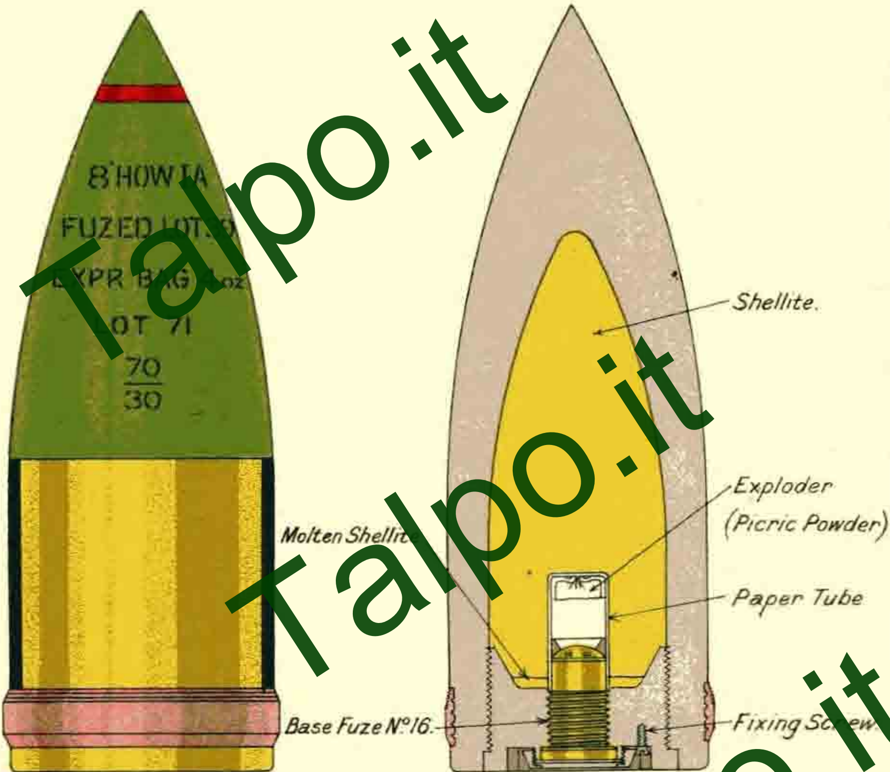
§5.20. Armour-piercing (A.P.) and armour-piercing capped (A.P.C.) shell.

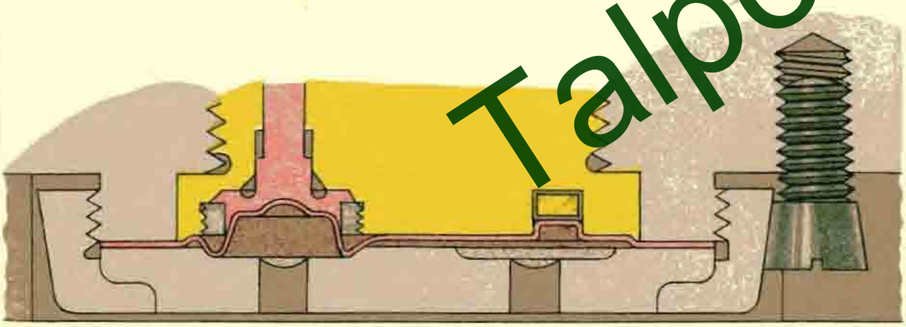
General design.—The definite object of these shell is to perforate armour and then burst effectively; every other consideration is subordinated to this end. At proof a successful shell is one that perforates the plate and emerges at the other side with the cavity for bursting charge intact.

To attain this purpose an A.P. shell is made of forged or cast steel, and has a pointed and solid head which is specially hardened. The walls are considerably thicker than those of C.P. shell to enable them to withstand the shock of impact, and are of toughened steel, in order to afford greater tenacity to ensure the shell holding together when striking hard-faced armour, especially at oblique impact. Its capacity is small in comparison with C.P. shell, as this is sacrificed in order to provide strength for perforation.

Fig 5·19(c).

METHOD OF FILLING:- SHELL B.L. C.P. (TYPICAL) FOR 6" GUN, 6" HOWITZERS & ABOVE. FIELD SERVICE.





ENLARGED VIEW OF BASE, SHOWING DETAILS FOR SEALING GAS PRESSURE.

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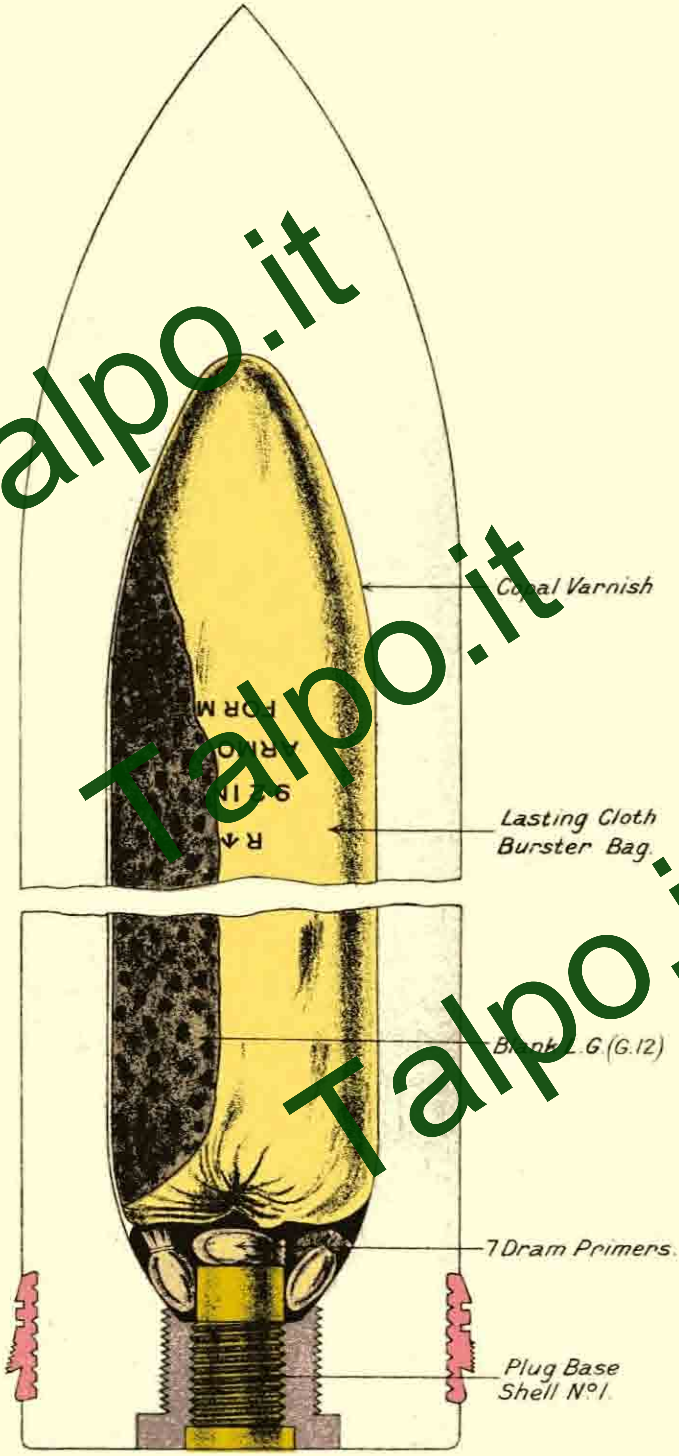
Fig. 5.20(a).

ARMOUR PIERCING SHELL FILLED POWDER.



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The c.r.h. of an A.P. shell is small, about 1·6 calibres, as the hole through the armour has to be punched as quickly as possible in order that the striking velocity may not be entirely lost before the shell gets through.

Owing to the hardening process to which the heads are subjected, they are liable to spontaneous splits. A.P. shell are stored, therefore, in the open for three months before final acceptance, to allow any latent crack to develop.

A.P. capped shell (*see* page 115) are used with the larger calibres, 6-inch and above.*

Filling of A.P. and A.P.C. shell.—A.P. and A.P.C. shell were formerly filled powder, and stocks of powder-filled shell are still

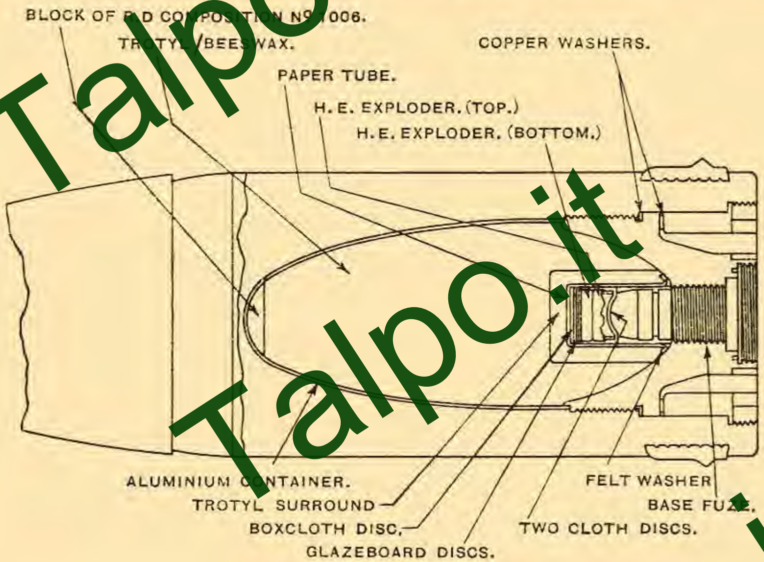

FIG. 5.20 (*c*).

held in the coast defences. In future, however, the filling will be H.E. There are also a number of shell in existence filled lyddite. The present approved filling for this type of shell is, however, trotyl or a mixture of trotyl and beeswax.

The filling of A.P. shell with powder is very similar to that of C.P. shell. The differences are :—

(*a*) Lasting cloth is used instead of dowlas, as it is closer in texture. There is no shalloon neck.

(*b*) G.12 is used instead of P.3 mixture.

A.P.C. shell filled powder are similar to A.P. shell, but have less capacity. There are no copper containers.

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* For further information on the attack of armour, *see* Appendices.

A.P.C. shell filled H.E. are lined with an aluminium container to guard against premature detonation due to spontaneous cracking of the hardened head. A cavity is left in the base of the filling, lined with paper, into which is placed an exploder containing picric powder for lyddite or shellite fillings, and trotyl for trotyl fillings. The space left by the shrinkage of the filling is filled with beeswax composition ; 3-pr. A.P. shell are filled lyddite without a container.

Armour-piercing shell with cap, filled H.E., Trotyl and Beeswax. (Fig. 5.20 (*c*).)

Fig. 5.20 (*c*) shows the latest type of A.P.C. shell ; it is also typical of the 6-in. C.P.B.C.

There exist, however, several earlier marks which will be found to differ in details regarding adapter fittings.

Closing the base of A.P. and A.P.C. shell (gunpowder filling).—A.P. and A.P.C. shell filled powder have a steel bush screwed into the base, which is screwed internally to take the fuze or plug.

Closing the base of all pointed H.E. shell (except 3-pr.).—Pointed shell are fitted with a base adapter of approximately the same diameter as the cavity.

The base of the fuze, or plug, is covered by a copper gas-check plate to prevent the propellant gases penetrating through or over the fuze or plug. The gas-check plate is held in position by a base cover plate consisting of a perforated steel plate and screwed ring, which engages with a thread cut in the adapter. Gas-check plates are essential for these shell.

§5.21. Semi-armour-piercing (S.A.P. and S.A.P.C.) shell H.E.

These shell are intended for use against lightly armoured vessels, such as submarines and light cruisers. They are similar in design to A.P. shell, but there is less material in the head, and the capacity is greater. Their penetrative power is superior to that of C.P. They are filled lyddite or trotyl, and the base is closed in a similar manner to other pointed H.E. shell.*

§5.22. High explosive (H.E.) shell.

Design.—H.E. shell are designed to cause damage to material by the force of their burst, or to personnel and aircraft by fragments.

Against earthworks, etc., the main consideration in design is that the bursting charge should be as large as possible. For example, in a large mortar bomb, the weight of the charge forms a

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* NOTE.—A table showing the fuze for each type of shell will be found on page 201.

A list of service plugs will be found in R.A.O.S., Part II, Pamphlet No. 1, Appendix VIII.

Fig. 5.20(b).

ARMOUR PIERCING SHELL WITH CAP FILLED H.E.

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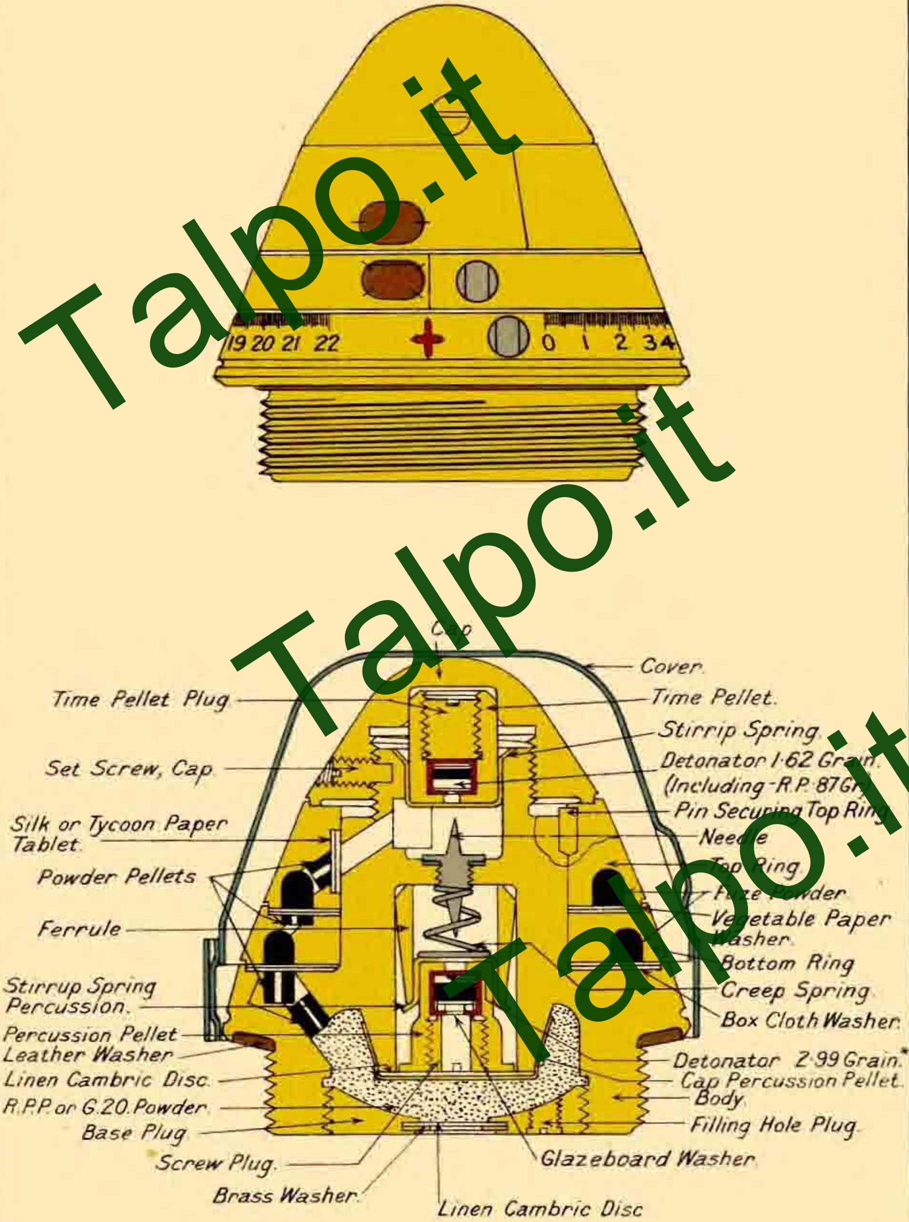
Fig. 6·25(a).

FUZE, TIME & PERCUSSION.

No 80, Mk XI /L/.



* Including 1·6 Grs. R.P.

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Fig. 6·25 (b).

FUZE, TIME Nº 80/44 Mk V/L/.

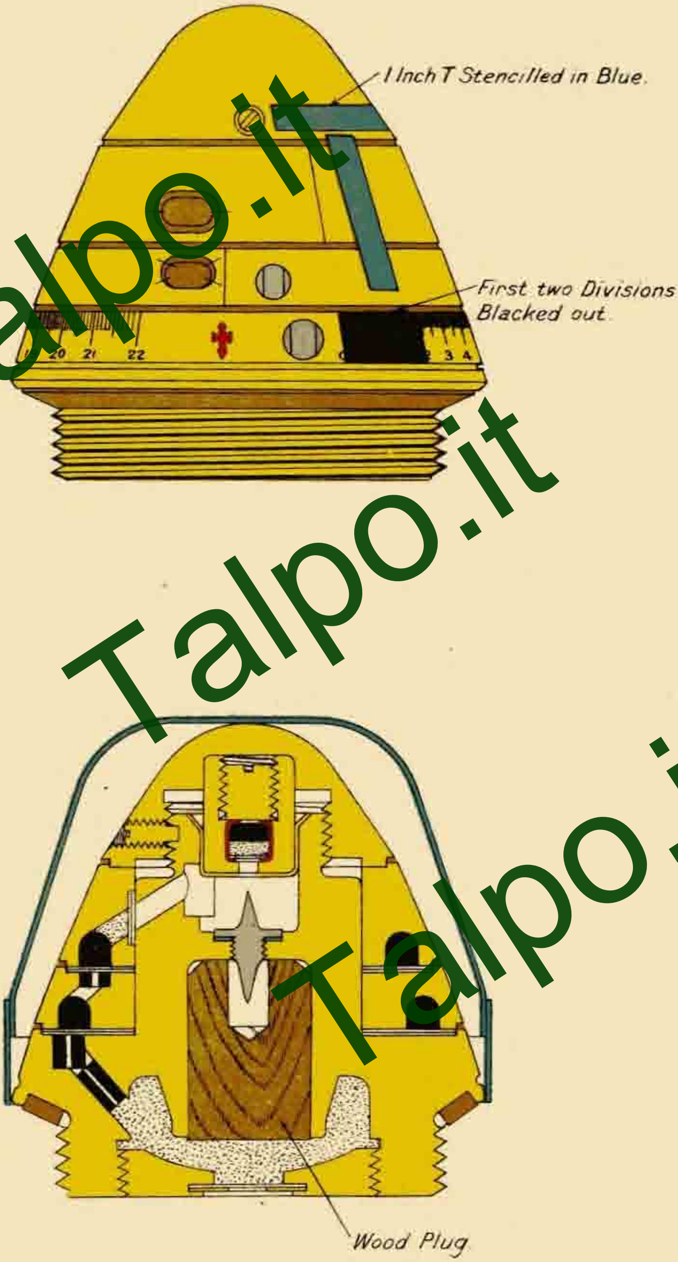
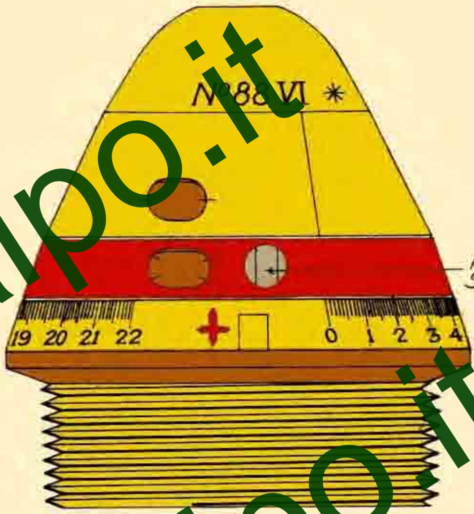
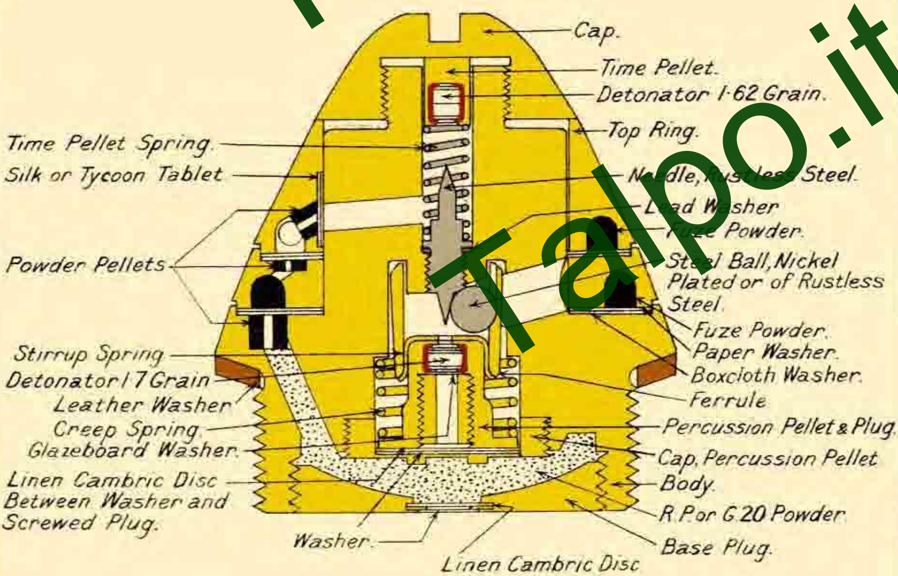


Fig. 6·26.

FUZE, TIME & PERCUSSION, No. 88 Mk. VI /L/.





sets back, straightening the arms of the stirrup spring, and travelling on, forces itself over the pellet to a rim at the base ; the creep spring prevents any forward movement of the percussion pellet during flight.

On graze or impact, the percussion pellet flies forward, overcoming the creep spring, and carries the detonator on to the point of the needle. The flash passes through the pellet and fires the magazine.

Safety arrangements.—When the setting on the lower time ring is opposite the red cross on the body, *i.e.*, when the fuze is set at safety, the flash holes to the lower time ring and to the magazine are masked by the bridges of the upper and lower time rings, respectively. This provides a double safety against ignition of the magazine, should the lighting mechanism act prematurely.

Fuzes should invariably be set safe during transport of ammunition. If rounds, of which the fuzes have been set, have to travel, then the fuzes must be re-set to safety, *not to zero*, in order to ensure safe transport of the ammunition.

The lighting pellet is protected by the cap of the fuze. Although this protection is sufficient for ordinary usage, yet it is possible for the fuze to be fired if the round is dropped heavily on to the cap, particularly if it be a fuze of which the cap is made of aluminium.

It is important, therefore, that the rounds should be handled with care, and that the fuzes should be set at safety during the transport of the ammunition.

§6.26. Fuze, time and percussion, No. 88, Mk. VI.

In general this fuze is similar to No. 80 fuze previously described.

The main differences lie in the mechanism of the lighting and percussion arrangements.

The time rings are similar except that the lower ring is filled with R.D. 202 composition, which gives the fuze a total time of burning of 48 seconds. The graduations, however, remain the same, 0 to 22. The lower ring is lacquered red.

Time mechanism.—The pellet with the detonator is supported by a coiled spring, which is strong enough to ensure safety during transit. There is a considerable distance between this detonator and the needle.

Percussion mechanism.—The percussion pellet with detonator occupies a central recess in the lower part of the body.

A stirrup spring, fitting over the top of the pellet, supports a ferrule, which keeps the detonator at a distance from the needle.

A metal ball is interposed between the pellet and the top of the recess.

A creep spring rests on the flange round the base of the percussion pellet.

Action of the time mechanism.—On discharge, the pellet sets back, overcoming the coiled spring, and carries the detonator on to the needle. The further action of the time mechanism is similar to that of the No. 80 fuze.

Action of the percussion mechanism.—The acceleration on firing causes the ferrule to set back over the pellet, straightening out the arms of the stirrup spring.

The rotation of the projectile causes the metal ball to fly out into a recess in the body.

"Creeping" during flight is prevented by the creep spring.

On impact, the pellet flies forward, compressing the creep spring, and carries the detonator on to the needle.

Safety arrangements.—The safety arrangements of the time mechanism are similar in principle to those of the No. 80 fuze.

The percussion mechanism has an additional safeguard in the metal ball, which ensures that the detonator cannot be touched by the needle until the ball has been moved clear by the action of centrifugal force.

In the earlier Marks of the fuze, the percussion needle was spun in, but in this Mark the needle is screwed in from the top. By this construction the needle is more firmly held and is capable of withstanding the forces set up on firing.

In the Mk. III, the time mechanism was placed eccentrically with regard to the axis of the fuze. There were, in consequence, two needles.

§6.26 (*a*). Fuze, time and percussion, No. 220 Mk. I.

The fuze is a tension type of 2-in. gauge.

The time portion is similar to that of the No. 199 fuze, but is located to one side of the centre line of the fuze.

The percussion arrangement is in the centre line of the fuze, and resembles that of the No. 101E fuze. The needle pellet is provided with a flash groove passing round the sides and bottom, so that on graze the flash has easy access to the magazine.

The dome shaped cap is fixed after tensioning by two set-screws.

When in the shell, a copper asbestos washer fits under the flange.

The top ring is filled with 30-second powder whilst the bottom contains R.D.202; the latter is therefore lacquered red.

The Mark II fuze differs only in the graduations, which are from 0 to 22.

§6.27. Fuze, time, No. 199, Mk. III.

This fuze has been introduced for anti-aircraft guns.

The various components and general structure of the fuze are shown on the diagram. The body and base plug are of unrestricted (class "G") metal.

Fig. 6·26(a).

FUZE TIME AND PERCUSSION, No 220 MARK I./L/.

Full Size.

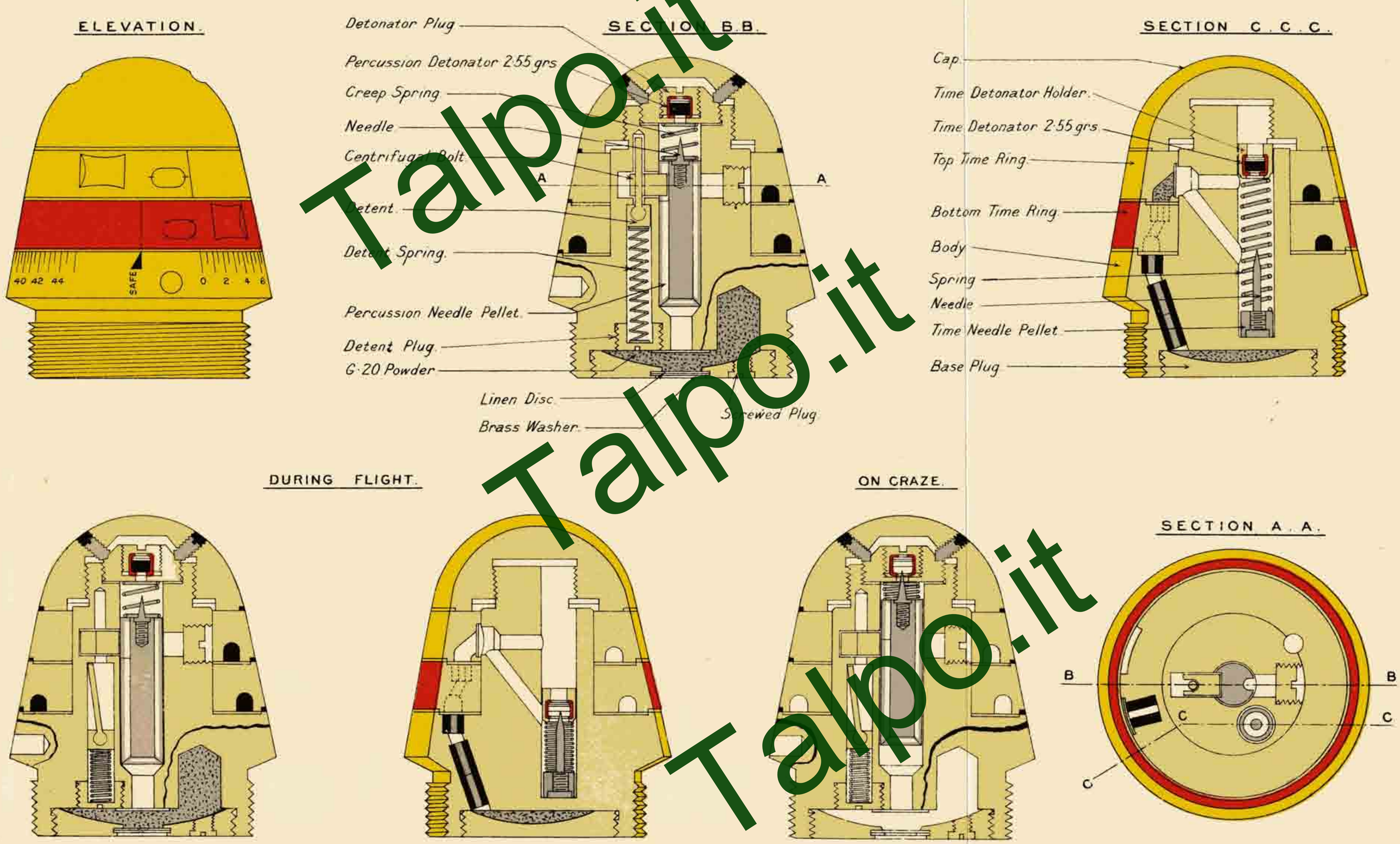
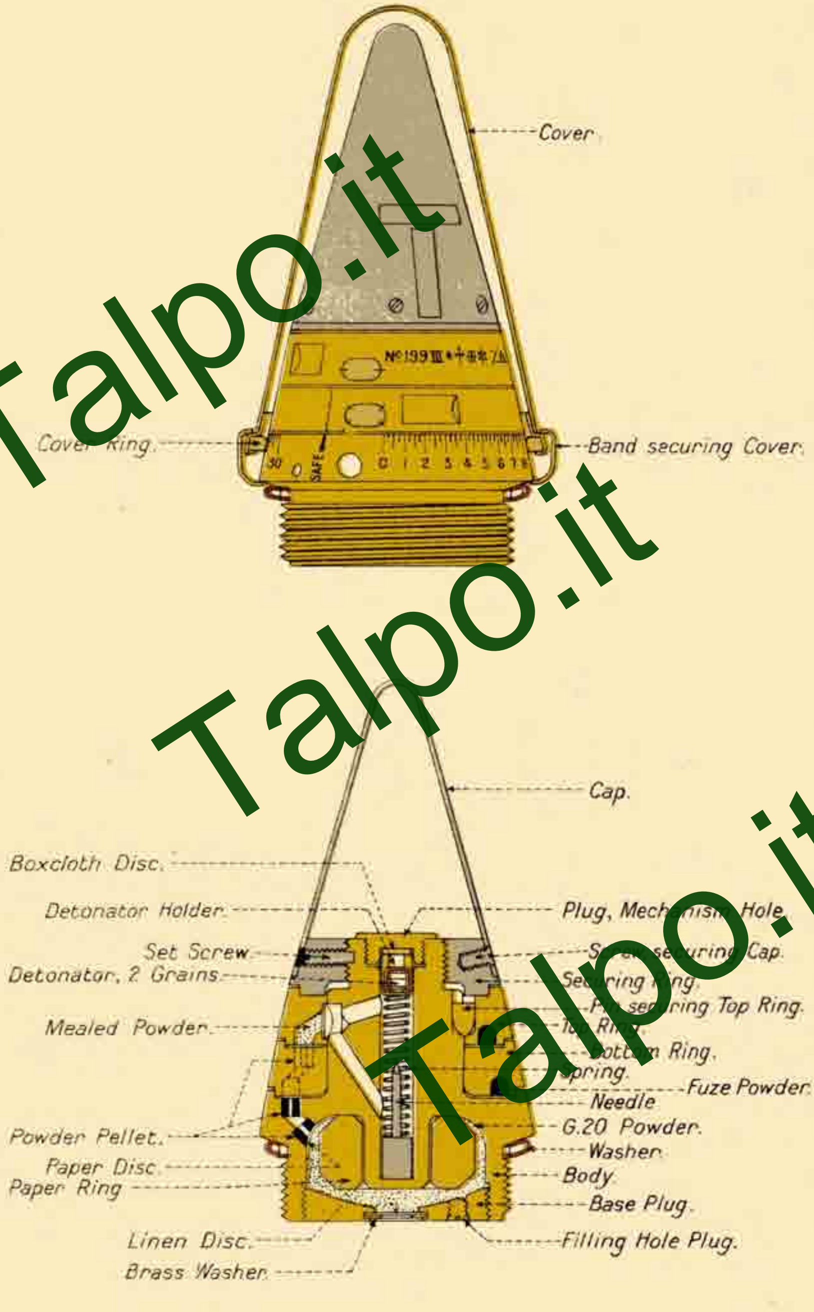


Fig. 6·27.

FUZE, TIME, Nº 199 MK III /L/.
WITH COVER.



The method of manufacture and filling is similar to that described for Fuze, T. & P., No. 88, except that there is no percussion arrangement ; the detonator is filled two grains detonating composition " B " mixture and G.20 gunpowder and the time rings are filled with a fuze powder of new composition to give a time of burning of 25 seconds. The upper ring is prevented from rotating by a single brass pin. Both rings have a setting slot.

There is a two-way channel leading from the lighting pellet chamber to the upper ring to allow the flame and gas from the detonator to circulate in the body of the fuze and so cause the ignition of the time ring to be less violent.

The markings round the fuze body are graduated 0 to 30.

Mk. I has small setting slots in top and bottom ring and the graduations are round the top ring.

Mk. II has widened setting slots in both rings and certain minor structural differences, otherwise as Mk. I.

Mk. III is similar to Mk. II except that the graduations are transferred from top ring to flange round the body.

Mks. I and II are now obsolescent.

Action of fuze.

Similar to that described for time mechanism of Fuze, No. 88.

§6.28. Mechanical fuzes.

Mechanical fuzes are time fuzes in which the time to burst is controlled by mechanical means in place of the burning away of a train of composition.

They may be divided into two distinct types :—

(1) Mechanical time fuzes, such as No. 203.
(2) Mechanical distance fuzes.

Advantages of mechanical fuzes.—In general the advantages of mechanical time and mechanical distance fuzes over the ordinary burning or composition time fuzes are :—

(*a*) The absence of irregularity in time due to inherent variation in the time of burning of batches of powder, and the detrimental action of the slag produced by combustion.

(*b*) The absence of variation caused by dynamic pressure at the escape holes of ordinary time rings and the rarification of the atmosphere at high altitudes. This is of importance in the case of fuzes fitted to shell fired at high angles of elevation against aircraft flying at considerable altitudes.

(*c*) The absence of variation in the rate of burning at high altitudes owing to the lowering of atmospheric temperature.

(*d*) The effect of spin is not so great at high spins as it is in the case of combustion fuzes.

(*e*) In the case of mechanical time fuzes, it is possible to test each individual fuze for time. This can only be done in the case of a combustion fuze by destroying it.

(*f*) Age should not affect a mechanical fuze, and in any case it can be tested for time-keeping at any period in its life and re-regulated if necessary. Nothing can be done with aged combustion fuzes, which burn irregularly.

Disadvantages of mechanical time fuzes.—

(*a*) They are, at present, expensive to manufacture, but this may be more than compensated by the life in store.

(*b*) The mechanism is affected by spin when the spin is high, but perhaps not to the same extent as a combustion fuze.

(*c*) Possible loss of tension in springs in storage, but there is not yet sufficient data on this point. The Germans experienced no loss of tension after ten years.

(*d*) Possible deformation in high velocity guns, but this point awaits proof.

§6.29. Mechanical time fuzes.

In this type the mechanism is designed to run at a predetermined rate after the fuze has been armed, this rate being little affected by the rotational velocity of the projectile in which it is fired.

The time of running or time of burst is, therefore, practically constant in any type of gun or howitzer. Consequently, the design has the advantage over others in that it is capable of being used in nearly all equipments, provided the time of flight is known, even though the range table does not include a scale for the actual fuze.

There are several different mechanical time fuzes in existence in the service, differing only slightly in their general make-up.

No mechanical types are at present in general use in the land service. A general description of Fuze, No. 203, is given. A list of the others is appended showing their essential differences from No. 203 fuze.

§6.30. Fuze, time, No. 203, Mk. I.

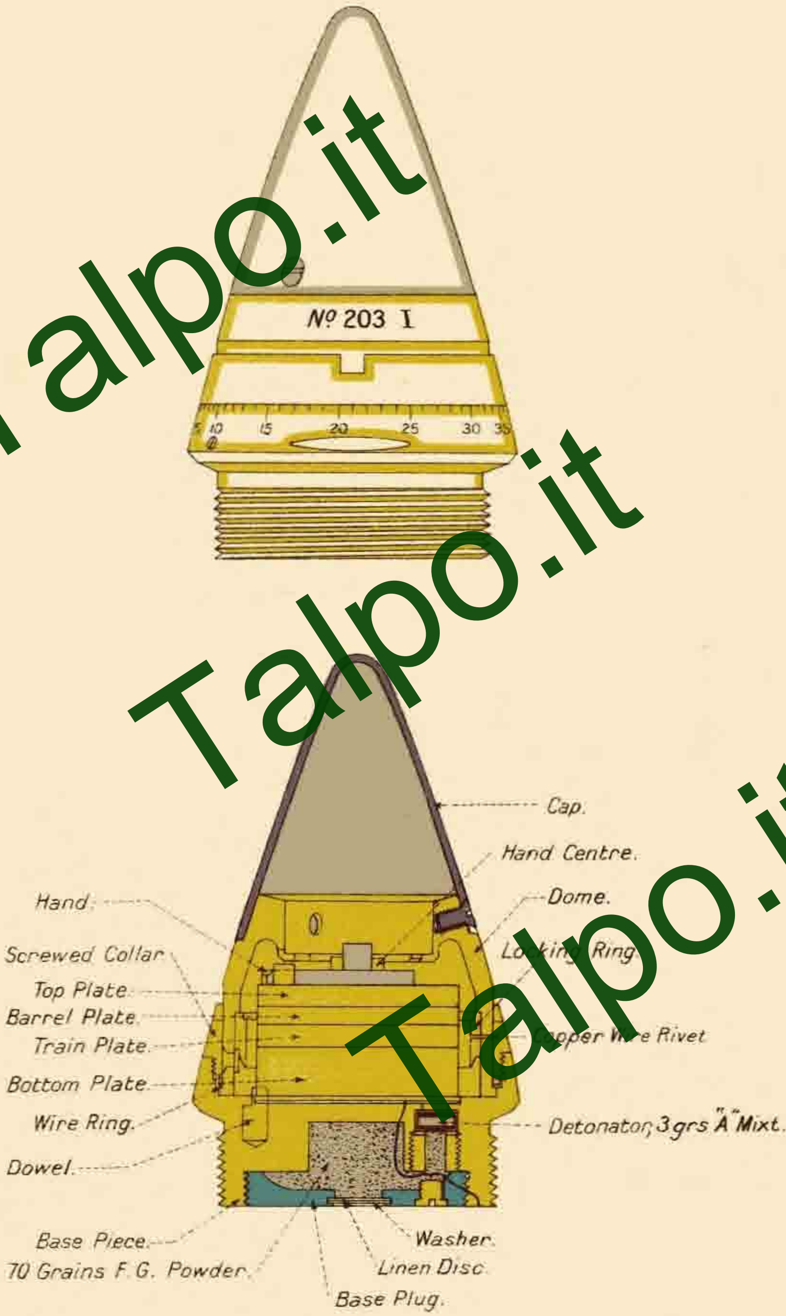
This fuze, designed to burst a shell at any interval of time up to 60 seconds after the firing of the gun, consists primarily of three parts:—

(*a*) The body.
(*b*) The magazine in the base of the body.
(*c*) The clockwork mechanism.

(*a*) The body consists of a metal base piece, screw-threaded to the 2-inch fuze-hole gauge, and provided with a flanged platform

Fig. 6·30 (a).

FUZE, TIME, Nº 203, Mk I.



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on which rests the dome with steel cap attached. The cap is conical and brought up almost to a point in order to continue the streamline contour of the shell into which the fuze fits.

At the top of the dome is a race-way, known as the "hand-race," which consists of a perfectly flat, smooth band of metal in true vertical relationship with the platform of the base-piece. This hand-race is slotted to accommodate the "hand."

Inside the dome, below the hand-race, a locking ring is held in position by means of three copper wire rivets passing right through the wall of the dome and the thickness of the ring. The lower edge of the ring is recessed so as to leave only a thin rim of metal. Five hollow-edged pins, which come immediately under the thin rim of the locking ring, are secured in the platform of the base-piece.

The dome is held in position by means of a screwed collar, which screws down into the flange of the base-piece, housing a tensioning wire between it and the flange provided at the base of the dome. The screwing down of the ring on to the tensioning wire regulates the turning movement necessary to rotate and set the dome. This turning movement is fixed at 250 inch-ounces plus or minus 25 inch-ounces.

(*b*) The underside of the body is hollowed out to form the magazine, and a hole through the diaphragm thus formed between the magazine and platform is bored and screw-threaded to take the detonator plug. Holes are also drilled to allow of the passage of the holding or anchoring screws of the clockwork mechanism.

The detonator is an ordinary igniferous detonator filled three grains Detonating Composition "A" mixture, and the magazine is powder filled and closed by a base plug in the usual manner.

(*c*) The "action" is a piece of unjewelled clockwork mechanism. It consists of a train of wheels operating a hand, the motive power being supplied by a mainspring. The hand itself is capable of rising out of its normal position under the influence of a spring, and is the main factor in the functioning of the fuze. The hand is double-ended, and is mounted on a hollow centre, the rim of which embraces a lip on the end of the striker lever. The striker lever is released by the rising of the hand. The shape of the hand is such as to allow it to rise vertically when it reaches a definite angular position of coincidence with the recesses in the hand-race.

The method of regulating the movement is based on the present-day watch-making practice, but the mode of application is different. In this mechanism a pallet and straight length of steel spring or phosphor-bronze ribbon take the place of the balance wheel and coiled hair-spring.

The pallet consists of four arms, two upstanding in such an angular position as to engage the teeth of the 'scape-wheel, the other two being flat and in a straight plane with the base plate of the movement. A small brass weight is placed at each end of the latter pair of arms in order to regulate the rate of oscillation of the pallet by the adjustment of the measure of weight.

The rate of oscillation is controlled by the straight hair-spring, which is secured centrally through the arbor carrying the pallet. The hair-spring has one end housed so as to be free to move radially in a saw-cut in the bottom plate of the movement, and the other end similarly secured in a radially adjustable block, which can be adjusted until the free length of hair-spring is such as to ensure the correct rate of oscillation of the pallet and therefore the correct rate of movement of the rotating hand.

The normal rate of oscillation is 87·98 complete beats a second.

The mechanism is anchored to the platform of the base piece by holding screws, and also embraces a number of safety devices described below.

Safety arrangements.—The main safety arrangements employed are as follows :—

(*a*) The safety catch (or centrifugal safety catch) to maintain the striker in the unarmed position.

(*b*) Trigger safety catch to prevent premature arming.

(*c*) A shearing pin to maintain setting at safety in storage and transit.

(*a*) The centrifugal safety catch is housed under the cam on the striker and serves a dual purpose—

(i) In the event of the movement being accidentally set in action, the striker, owing to its being upheld by the interposing catch, is prevented from reaching the detonator.

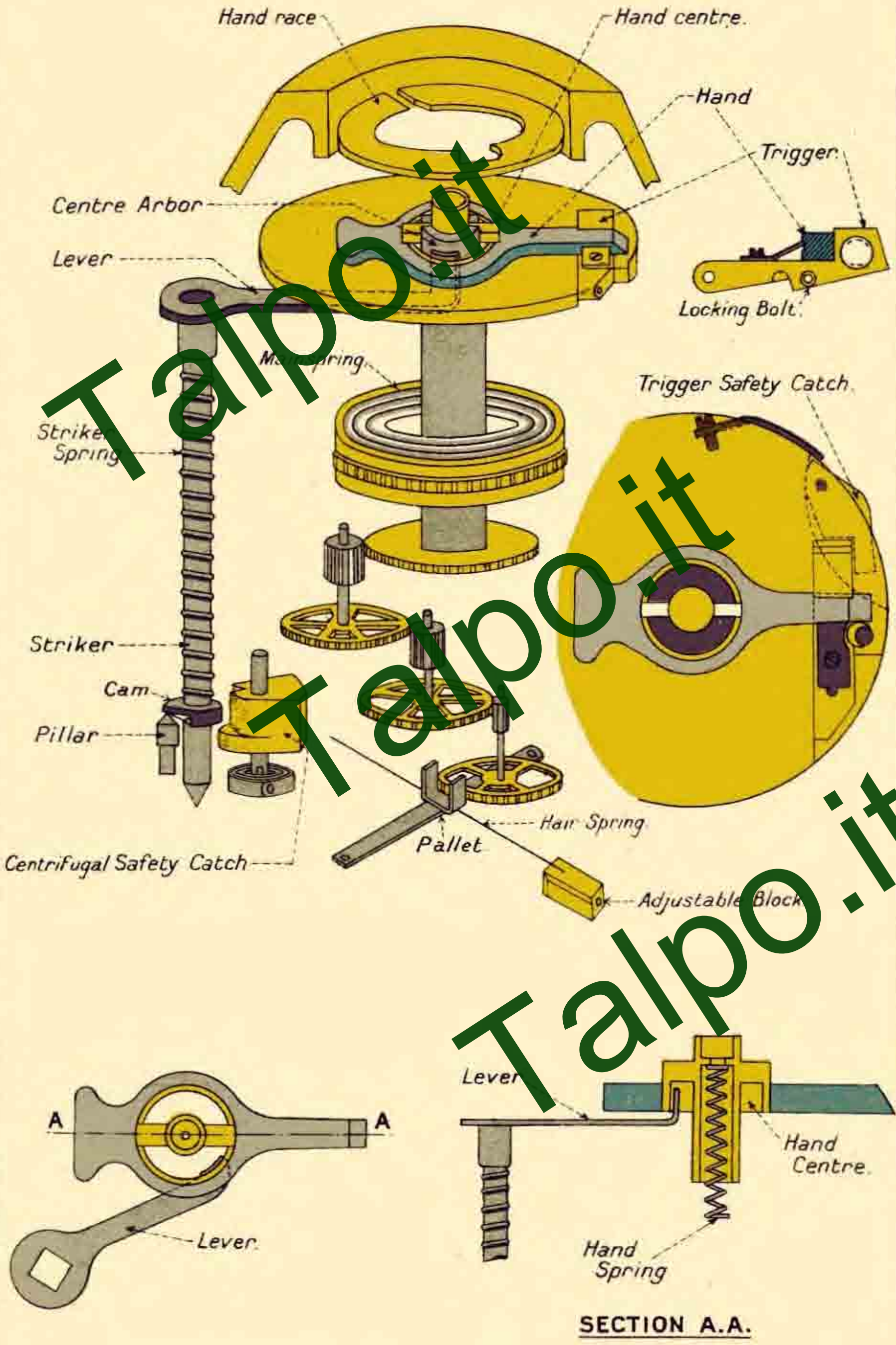
(ii) If a fuze in this condition were loaded into a gun and the gun fired, the catch would be prevented from swinging out from under the striker, because the latter would immediately jamb down on to a step cut in the catch for that purpose, and hold it firmly in place.

(*b*) The hand is secured against movement by means of a trigger pivoted on the top plate of the movement at one end, the opposite end being provided with a lip of overhanging metal, which engages the hand and retains the trigger in position. The trigger, being free to move up and down, is controlled by means of an eccentric screwed to the top plate and overlapping the edge of the trigger, thus preventing any tendency of the trigger to rise under the influence of the hand spring. It has, of course, to descend in order to free the hand, but once down it must not be allowed to reassert itself due to rebound. This is countered by a small locking bolt which functions under the action of a spring immediately on descent of the trigger.

A trigger safety catch is housed under the trigger in order to

Fig. 6·30 (b).

FUZE, TIME, No 203, Mk I.



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prevent its being prematurely functioned. The catch is withdrawn immediately the fuze is set away from the safety mark.

(*c*) The shearing pin of copper passes through a small hole in the flange of the base piece and dome, and is for the purpose of preventing the possibility of the dome being accidentally moved in transit after being issued set at safety.

Assembled fuzes.—The clock is fully wound before being secured in position in the body. The striker point is immediately above the centre of the detonator.

The dome and base piece carry setting dots for use with a fuze setter, the setting depending upon the relative positions of the hand of the movement and the dome hand race slots.

The fuze is waterproof to prevent ingress of moisture, and is secured against interference as regards its tension by locking the screwed collar in position after tensioning the fuze.

Action.—On firing, the locking ring in the dome shears its suspending wires and sets down on to the steel pins in the platform of the base piece, thus locking itself and preventing any shifting of the dome from the position it was set in, by reason that a feather or guide pin in the dome engages a slot or featherway in the locking ring. The trigger descends and is caught by the locking bolt, releasing the hand: during acceleration in the bore it is unlikely that the pallet will oscillate owing to the force of " set-back "; when the muzzle is reached the hand begins to rotate under the influence of the mainspring. After acceleration ceases, the centrifugal safety catch, flying out under the influence of centrifugal force, leaves the striker supported only by its cam resting on the sloping surface of the pillar provided for the purpose.

The fuze having reached its setting, the hand is brought immediately under the slots in the hand race into which it rises under the influence of its spring, and releases the lever controlling the striker. The lever flies outwards owing to centrifugal force, and the action of the striker spring turns the cam of the striker off the pillar, the sloping surface of the latter facilitates this action, and the striker fires the detonator and the powder magazine.

The other mechanical fuzes are :—

§6.31. Fuze, time, No. 200.

This fuze differs from No. 203 in respect of the dome-locking device, and in being without a safety catch under the trigger.

The clock is contained in a clock case having a flanged base, and the pins are affixed in the locking ring instead of in the fuze platform. The locking ring is also suspended by springs instead of shearing wires.

On firing, the locking ring sets out of the springs, the pins puncture the clock case rim, and thereby lock the dome, as in the case of No. 203.

Fuze, time, No. 201.

This fuze is identical with No. 200 except that it is timed to run 85 seconds instead of 60. So far, none have been made and formal approval is still withheld.

Fuze, time, No. 202.

This fuze is identical with No. 203, but is for use in naval service only.

Fuze, time, No. 204.

This fuze consists of the No. 200 mechanism made in France, fitted with centrifugal safety catch as in No. 203 (*i.e.*, locking step) and fitted to bodies pertaining to the No. 203 design.

Fuze, time, No. 205.

Is similar to No. 203, but with contour for use with 3-inch 20-cwt. 16-lb. shell.

Fuze, time, No. 206.

Differs principally from the No. 202 fuze in being fitted with a modified clock mechanism giving a running time of 45 seconds. The bottom ring is graduated in seconds and marked 0–225, the figures representing the number of 1/5th seconds of time. The fuze is fitted with a cover similar to that for the No. 202. It is used in the naval service.

Fuze, time, German, converted, Dopp Z 16.

It was from this fuze that the No. 200 was developed. It is identical for all practical purposes with the No. 200, except as regards the fuze-hole gauge. To render it suitable for use with the 2-inch fuze-hole an adapter is necessary. It is also fitted with centrifugal safety catch of the No. 203 type (*i.e.*, locking step).

§6.32. Mechanical distance fuzes.

Under this heading are included those fuzes in which the time burst depends on the distance travelled, or more strictly on the number of revolutions the fuze makes about a spindle which passes through its axis. The spindle is held against rotation by means of vanes, or by the attachment of some pendulous weight or similar "inertia" member.

This type of fuze is therefore inoperative until fired. Its time to burst is dependent upon and varies with the muzzle velocity, the pitch of the rifling, and the calibre.

This design requires no self-contained driving force such as a mainspring.

On the other hand, the necessity for the projecting vanes or other exterior inertia member introduces, in the majority of cases, a grave risk of failure due to injury during loading.

No fuzes of this type yet exist in the land service.

PRESERVATION OF FUZES

§6.33. Effect of climate.

Fuzes deteriorate when exposed to damp, and climatic conditions affect fuzes adversely, especially abroad in hot moist climates.

The injury is permanent and tends to increase with time, although there may be no further exposure.

Moisture acts on the detonators, and, if they become affected, blinds or unsatisfactory bursts may result. Damp also acts on the composition of time fuzes. It may lengthen the time of burning, prevent ignition, lead to a premature functioning of the fuze, or cause the rings to become so tight that they cannot be set by hand. This latter defect is frequently met with in time and time and percussion fuzes of war-time manufacture. It is caused by the composition in the time rings swelling and thereby taking a firm grip on the boxcloth washers.

Dampness also corrodes the bodies of fuzes, especially those parts made of aluminium. It rusts or corrodes safety pins, making them difficult to withdraw.

In mechanical fuzes moisture disturbs the harmonious working of the clock. Precautions have, therefore, to be taken to protect fuzes, particularly time fuzes, from damp.

§6.34. Fuze Cylinders.

Fuzes, when issued separately from shell are packed in tinned-plate cylinders. The lids are hermetically sealed by a tin strip soldered on, and the cylinders are vacuum tested before issue.

In certain cases where fuzes are only to be issued to home units, the lids are tape-banded, *i.e.*, sealed by a piece of tape shellaced on.

Each cylinder has a label on the top, showing the number, nature, Mark, filled lot number, date of filling and packing, and the filler's initials.

Painting of fuze cylinders.—Fuze cylinders containing time and time and percussion fuzes having the 2-inch gauge are painted green. Those containing detonating fuzes are painted yellow. All other cylinders are painted black.

§6.35. Waterproofing and sealing of fuzes.

All openings in percussion fuzes are coated with R.D. cement or waterproofing composition to prevent the ingress of damp.

In all the latest time and time and percussion fuzes, the spaces between the cap, time rings, and body, also the set-screw recess of the cap, and the escape hole discs in the time rings, are now waterproofed with a composition of beeswax, mineral jelly, and french chalk.

The base plugs are waterproofed by having the threads coated with R.D. cement before being screwed in, and then the whole of the base is covered with R.D. cement.

§6.36. Fuze covers.

Time and 80 type T. & P. fuzes are, with minor exceptions, further protected by sealed covers. The covers may be made of brass, tinned-plate, or lead foil. Only brass and tinned-plate covers now exist for the No. 80 fuze.

The cover is cup-shaped to fit over the fuze, and is secured by soldering a brass band to the junction of body of fuze and cover. It forms an integral part of the fuze.

Lead foil covers are not now fitted.

Metal covers with tear-off bands once removed cannot be replaced, that of the 199, however, is replaceable.

All covers should be fitted in a dry atmosphere.

The chief essentials of a cover, neglecting questions of manufacture, cost, etc., are :—

(*a*) Their capacity of withstanding rough treatment, without rendering their removal difficult, or losing their air-tight property.

(*b*) Their ease of removal without the use of special tools, and without injury to the operator.

(*c*) Their freedom from projections or fringes left on the fuze after stripping, which might influence the subsequent flight of the projectile.

MORTAR FUZES

§6.37. Introduction.

As mortar fuzes differ essentially in some respects from fuzes used in gun ammunition, it has been considered preferable to treat them separately.

All general remarks on fuzes, their function, design, water-proofing, etc., naturally apply to these mortar fuzes, so that the description of the types that follow must be read in conjunction with any statements of a general nature already made.

Mortar fuzes may be divided into two classes :—

1. Percussion fuzes.
2. Time fuzes.

Percussion fuzes.

There were three distinct types of percussion fuze :—

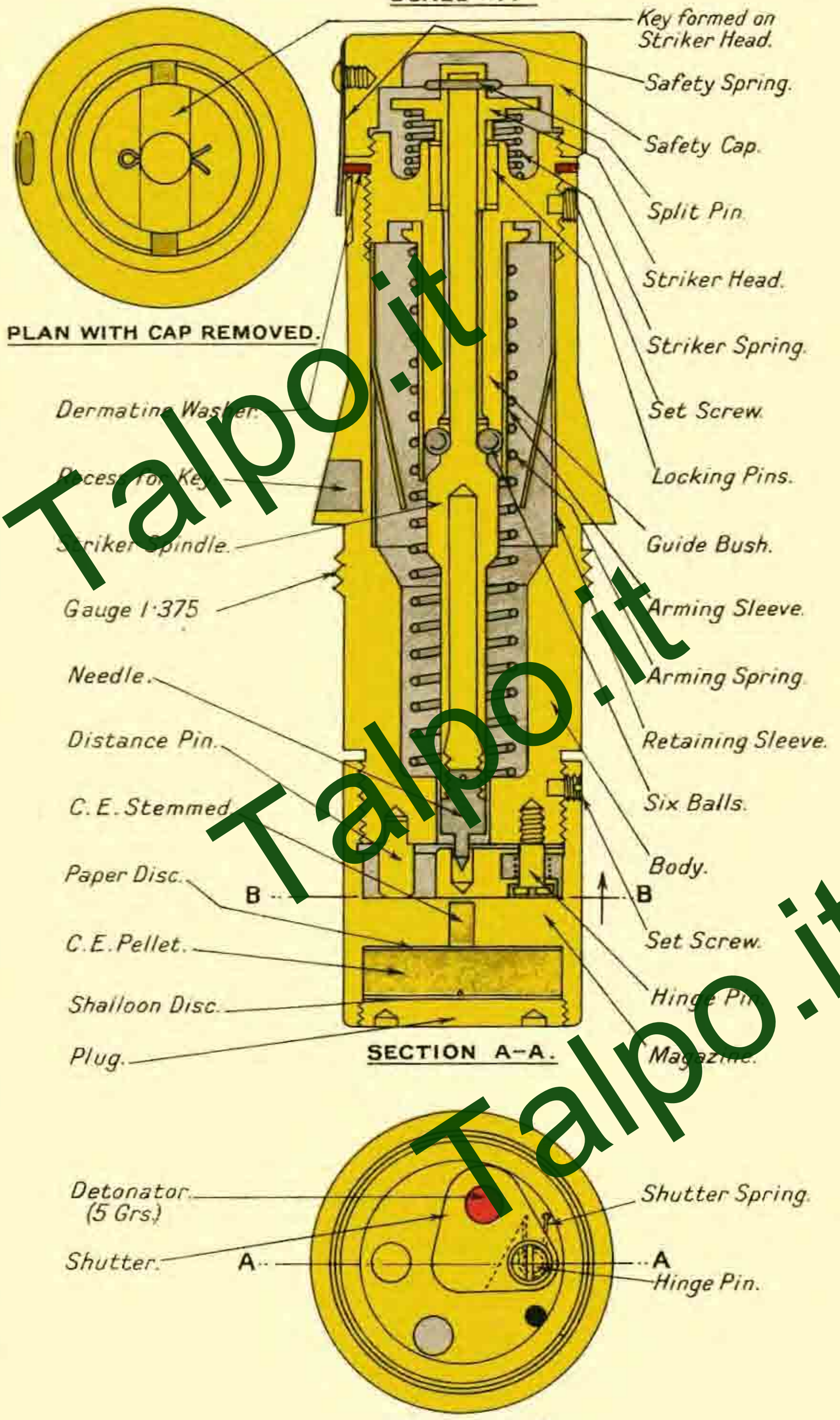
(*a*) *The direct action type.*

This type is similar in principle to an ordinary D.A. gun ammunition fuze. Its functions on impact by having the needle forced home on to the detonator.

Fig. 6·38.

FUZE, PERCUSSION, D.A. Nº 138, Mk I/L/. WITH CAP.

SCALE-1/1.



PLAN WITH CAP REMOVED.

SECTION A–A.

SECTION B–B.
LOOKING IN DIRECTION OF ARROW.

(*b*) *The all-ways type.*

This type has the capability of functioning as soon as any part of the cylindrical bomb, to which it is fitted, strikes the ground. The fuze itself need not be touched by the impact. This type is now obsolete.

(*c*) *The pistol type.*

This type only contains the mechanism of a fuze; it is used in conjunction with a detonator carried separately in transport, and fixed into the bomb itself when preparing for action. It is now obsolete.

Three percussion fuzes exist for mortars at present. These are :—

Fuze, Percussion, D.A., Nos. 138, 139 and 139P, and are used in the vaned type of 3-inch mortar bombs.

§6.38. Fuze, percussion, D.A., No. 138, Mk. I.

The construction and action of this fuze is generally similar to the No. 117 described on page 169.

In the design of mortar fuzes which are to be fitted with shutters to render them safe in transport and during acceleration in the bore, the following points should be considered.

(i) In a mortar the chamber pressure available for arming a fuze is relatively of a low order—usually under 2 tons to the square inch—and, further, the acceleration period is of short duration.

(ii) As the mortar is smooth bore, no spin can be imparted to the bomb; neither is it possible for practical considerations to twist the vanes, as stability in flight and air resistance must be taken into consideration.

The general differences from the No. 117 fuze are given below (*see also* Fig. 6.13).

The shutter containing a five-grain fulminate detonator is held against the shutter spring by the point of the striker.

The arming sleeve surrounds the striker and retains six steel balls in a seating, these together with the sleeve and arming spring retain the striker, and therefore the shutter, in the safe position.

Above the guide bush is the striker head, striker spring, split pin, two locking pins and safety cap.

The striker head on its top surface is shaped to form a key; the interior of the safety cap is cut to form a key-way. The striker head is extended to form a sleeve which has two semi-circular recesses; the guide bush is also prepared in a similar manner. Into these recesses fit the two locking pins. Thus if the fuze should accidentally arm, and the cap be turned, the feather on the striker head enters the featherway inside the safety cap, thereby locking the cap, striker head and striker to the fuze body, through the medium of the two locking pins and guide bush. The two locking pins allow vertical but not rotary movement of the striker.

Action of the fuze.—The cap is removed before loading. If the cap is difficult to remove by hand, it must not be forced, as the fuze may have become armed through rough usage and consequently be in a dangerous condition.

On acceleration, the arming sleeve sets back, compressing the arming spring until it is tripped by the tongues of the retaining sleeve ; the balls are now free to fall out of their seating. The striker spring under the head now forces up the striker, the point of which leaves the hole in the shutter. The shutter spring forces the shutter containing the detonator into the armed position.

On impact the striker is forced in and the needle enters the detonator initiating detonation.

§6.39. Fuzes, percussion, Nos. 139 and 139P.

These are D.A. fuzes, and the construction of the No. 139 can be seen from Fig. 6.39. It is generally similar to Fuze, Percussion, D.A., No. 44, but the safety shutter is omitted, since there is no rotational velocity to open such a fitting.

The D.A., No. 139P, fuze is similar to the No. 139, but is filled with gunpowder instead of C.E. The cap of this fuze is painted with red lacquer as a means of identification.

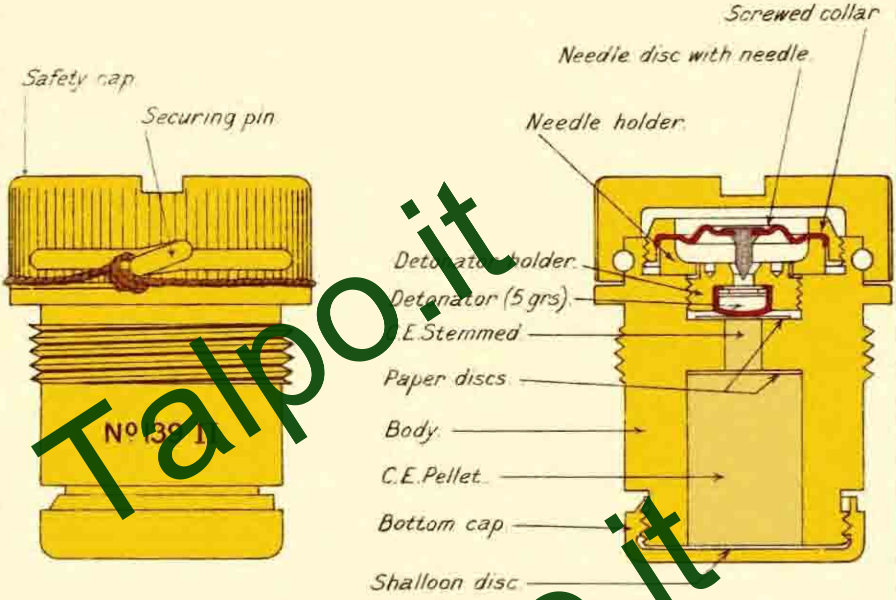
§6.40. Rust-proofing.

In all mortar fuzes, those components made of iron or steel must be efficiently rust-proofed, in order to avoid deterioration setting in owing to damp, the usual process being electro-tinning.

Fig 6·39.

FUZE, PERCUSSION, D. A., Nº 139 Mᴷ II.

SCALE :- 1/1.



FUZE, PERCUSSION, D. A., Nº 139 P. Mᴷ II.

SCALE :- 1/1.

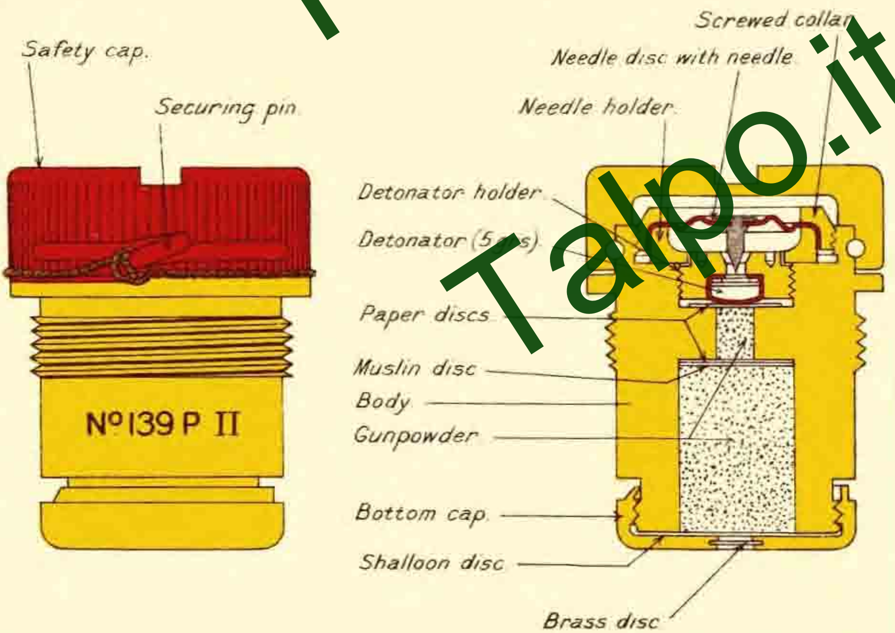


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TABLE 6.41

FUZES FOR LAND SERVICE

FIELD AND MOBILE ARTILLERY

Percussion fuzes.

(*a*) Direct-action fuzes.

Fuze	Projectile	Equipment
No. 44 ...	H.E. Shell	B.L. 9·2-inch gun. „ 6-inch gun.
	Smoke Shell	Q.F. 4·5-inch how.
No. 106 ...	H.E. Shell	Q.F. 18-pr. (Service only). Q.F. 13-pr. (Service only).
No. 106E ...	H.E. Shell	B.L. 18-inch how. „ 14-inch gun. „ 12-inch how. „ 9·2-inch gun and how. „ 8-inch how. „ 6-inch gun and how. „ 60-pr. Q.F. 4·5-inch how. „ 3·7-inch how. and mortar. „ 18-pr. „ 13-pr.
	Smoke Shell	B.L. 6-inch how. Q.F. 4·5-inch how. „ 3·7-inch how. or mortar. „ 18-pr.
No. 106P.E.	Practice Projectile... ...	B.L. 6-inch how. (*z*) „ 60-pr. (*z*). Q.F. 4·5-inch how. (*z*). „ 3·7-inch (*z*). „ 18-pr. (*y*).
No. 106P.D.	Practice Projectile, powder filled.	B.L. 6-inch how. „ 60-pr. Q.F. 4·5-inch how. „ 3·7-inch „
No. 117 ..	H.E. Shell	B.L. 6-inch how. (86-lb. shell). „ 60-pr. (56-lb. shell). Q.F. 18-pr. (streamline shell).
	Smoke Shell	Q.F. 18-pr. (streamline shell).

(*z*) Powder filled.
(*y*) H.E. filled.

The aluminium or tinned brass *centre piece* which is screwed into the base of the bomb, consists of two chambers.

In the upper end of the central, and larger, chamber is seated the striker with its compressed spring. When the grenade is prepared for firing, the detonator is inserted from the base so that the cap end of it is seated at the bottom end of this chamber below the striker, the other end formed by the detonator sliding into the side chamber. This eccentricity of the detonator is a disadvantage, as the bulk of the H.E. filling is partially isolated from it by the air gap which the striker chamber interposes, and uneven fragmentation is thereby caused.

The detonator consists of a ·22 rim-fire cartridge, seated in a zinc alloy cap chamber, and is attached to one end of the safety fuze, the other end of which is crimped into a No. 6 detonator. The fuze is bent into a U-shape to suit the centre piece into which the set fits.

The *striker* is of steel, flanged at the bottom to seat the spring; its firing face is shaped for rim firing, and notched to allow the escape of gas through the flange.

The shaft of the striker passes out through the body of the grenade, and is notched at the top to receive the striker lever.

The *striker lever* is a curved steel lever, pivoted on a fulcrum formed on the body of the grenade. The curved lever fits closely to the body, and is retained in position by a pin passing over it and through the fulcrum bracket. The short counter lever fits into the notch on the striker and holds it up against the force of the compressed spring.

Filling.—Trotyl, baratol 20/80, or 40/60, but trotyl is obsolete for future filling.

Amatol, ammonal, alumatol, etc., are obsolete.

Action.—In preparation for action the base plug is unscrewed and the detonator No. 36M grenade inserted.

Preparatory to immediate use, the safety pin is withdrawn and the lever held down by hand during the act of throwing. When fired from a discharger the curved lever rests against the side of the cup, and is held there till the grenade is projected.

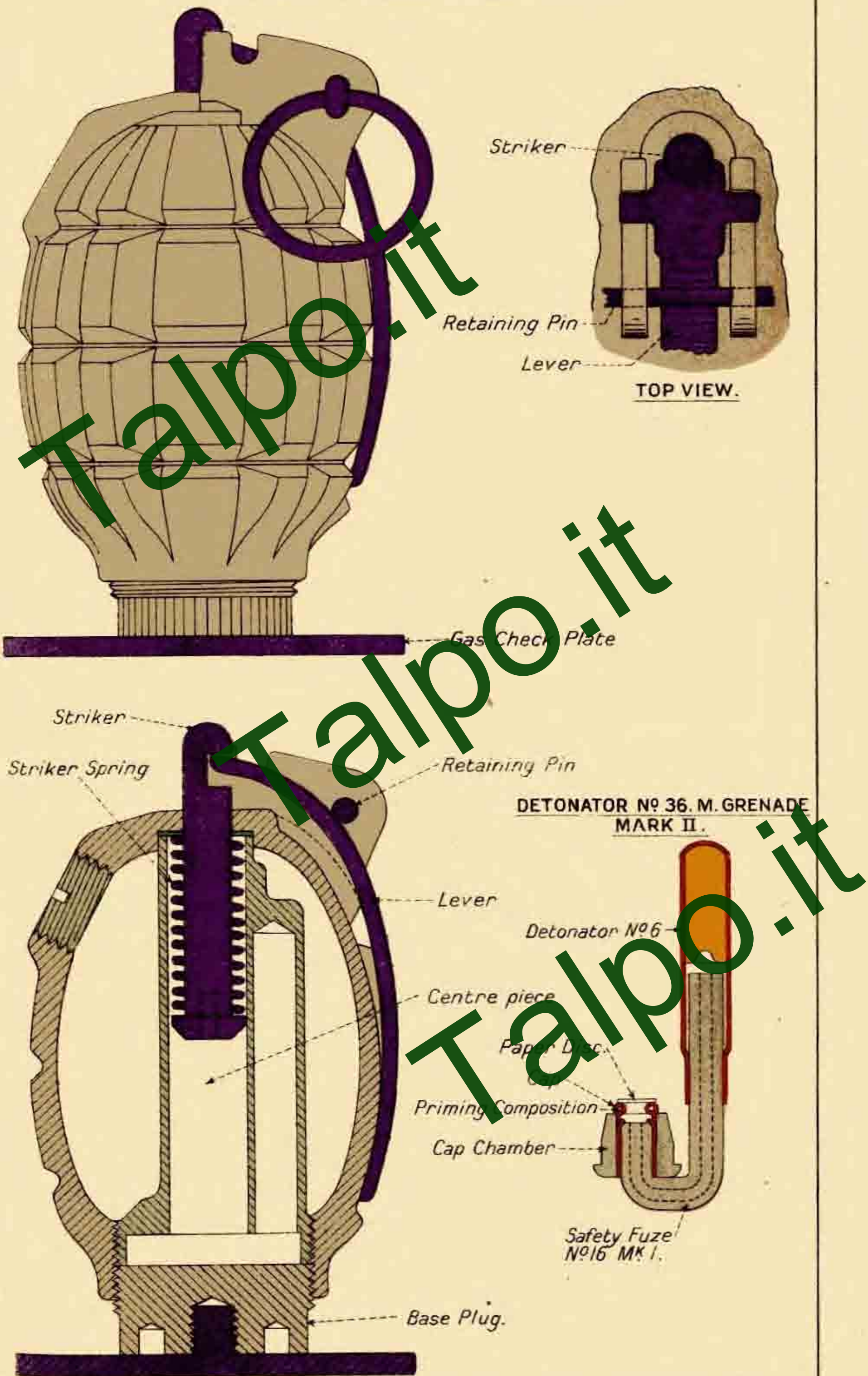
On release, the lever pivots on the fulcrum, the striker descends under the force of the spring, throwing the lever clear and firing the cap. The cap ignites the safety fuze, which burns for six seconds before firing the detonator which detonates the filling.

The No. 36M, Mk. I, differs from the No. 36 in having the screw threads of the base plug and centre piece, and the portion of the striker head where it emerges from the top of the grenade, covered with a special waterproofing composition for use in tropical climates.

The No. 36M has entirely replaced the No. 36, which is now obsolete.

Fig. 10·04

GRENADE No. 36. M. Mk. I.



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Packing.—Box G.5, Mk. III or Box G.36, Mk. I.
Containing—
- 12 Grenades.
- 12 Detonators in tinned-plate cylinder.
- 14 Rifle Grenade Cartridges in tinned-plate box.
- 12 Gas-check plates.
- 1 Key.

§10.05. Signal grenades.

The oldest types of signal grenades are rodded. These were all declared obsolete for future manufacture in 1920 and few will be found in the service.

They are made of tinned plate cases and ignited with an igniter consisting of an Eley cartridge head pressed on to a length of safety fuze. A striker, suspended by a shearing wire, and locked, till fired, by a safety pin held over the cartridge in a tubular striker chamber. The igniter screws on to a spigot on top of the grenade. Ignition from above entails the packing of the components in the reverse order to that used in the grenades (subsequently described) fired from a discharger. The parachute is at the bottom of the case and the base cover, which carries the rod, is a sliding fit. The grenade opens at this end when the bursting charge throws out the contents.

The modern signal grenade is fired from a 2½-inch discharger. These are enumerated below with their rodded prototypes.

Rodded	2½-inch Cup	Designation	Contents	Marking
No. 31, Mks. II and III	No. 42, Mk. I	Day Signal	1 smoke candle, Red, Blue, Yellow or Purple	A serpentine line coloured according to candle.
No. 32, Mks. II and III	No. 43, Mk. I	Night Signal	3 stars, Red, Green or Yellow	3 coloured discs according to the colour and sequence of the stars.
No. 38, Mk. II	No. 45, Mk. I	Night Signal	1 changing colour star, "Red to Green to Red" and "White to Red to White."	*3 rectangles according to colour sequence of enclosed stars.
No. 51, Mks. I and II	No. 52, Mk. I	Day or Night Signal	3 White illuminating stars	3 white discs and "Day or Night."
	No. 48, Mk. I	Day or Night locality signal	4 flash signals suspended on a string 2 ft. apart and igniting at ½-sec. intervals	No distinguishing marks. Painted drab and a descriptive label attached.

* Coloured bands round the body in the case of the No. 38.

§10.06. Signal grenades 2½-inch, Discharger type.

The general construction of all 2½-inch types of signal grenades is the same.

The body is a rolled paper cylinder closed at the base by a wooden plug perforated by two holes. The base is covered by a brass base cap, which is strengthened by a small steel disc in centre. The cap is perforated by two holes coinciding with the holes in wooden plug.

The front end of the body is closed by a tinned-plate cap.

A *supporting collar* of tin-plate fits over the edge of the discharger cup and prevents the rain getting in when the loaded rifle is ready for use.

The perforations in the wooden plug are filled with lengths of safety fuze to ignite the opening charge, the base ends of the safety fuze are exposed in order that they may be ignited by the cartridge.

The *opening charge*, consisting of a layer of 1-drm. F.G. or G.12 powder, is placed on top of the wooden plug. Over the opening charge is a perforated felt wad, on which rests the star or candle. On the top of the star or candle is a perforated cardboard disc to support the parachute and cord which lies in the front end of the grenade.

The *parachute* of japanned paper is fixed by asbestos cord to the star or candle. The end of the cord is brought through the cardboard disc and is attached to the star or candle.

Action.—On firing, the safety fuze is ignited and burns for about ½ second to allow the grenade to get clear, it then ignites the opening charge which throws out the star or candle, which is suspended by the parachute. At the same time the opening charge ignites the priming (usually quick-match) of the star or candle, the ends of the quick-match being brought down through the hole in the felt wad and into the opening charge.

Packing.—Box numbered according to contents :—

24 grenades.
28 rifle grenade ballistite cartridges.

§10.07. Grenade No. 54, Mk. I (obsolete from 20.11.35).

The body is a symmetrical iron casting, with walls about 3/16 inch thick. Circumferential guides are cast on the exterior and are machined to be a close fit in the 2-inch discharger cup.

The casting is screw-threaded to receive the mechanism chamber at its upper end, and a base plug at its lower end. A side filling hole, closed with a screwed plug, is provided through the wall.

The *holder or mechanism chamber* is a die-casting which is screwed into the top of the body.

At its lower end is secured a copper tube, which, when the chamber is assembled to the body, is flanged over at its lower end and sweated to the seating provided in the base plug hole.

Fig 10·06(a).

GRENADE, SIGNAL, (DAY) Nº 42. MARK I.

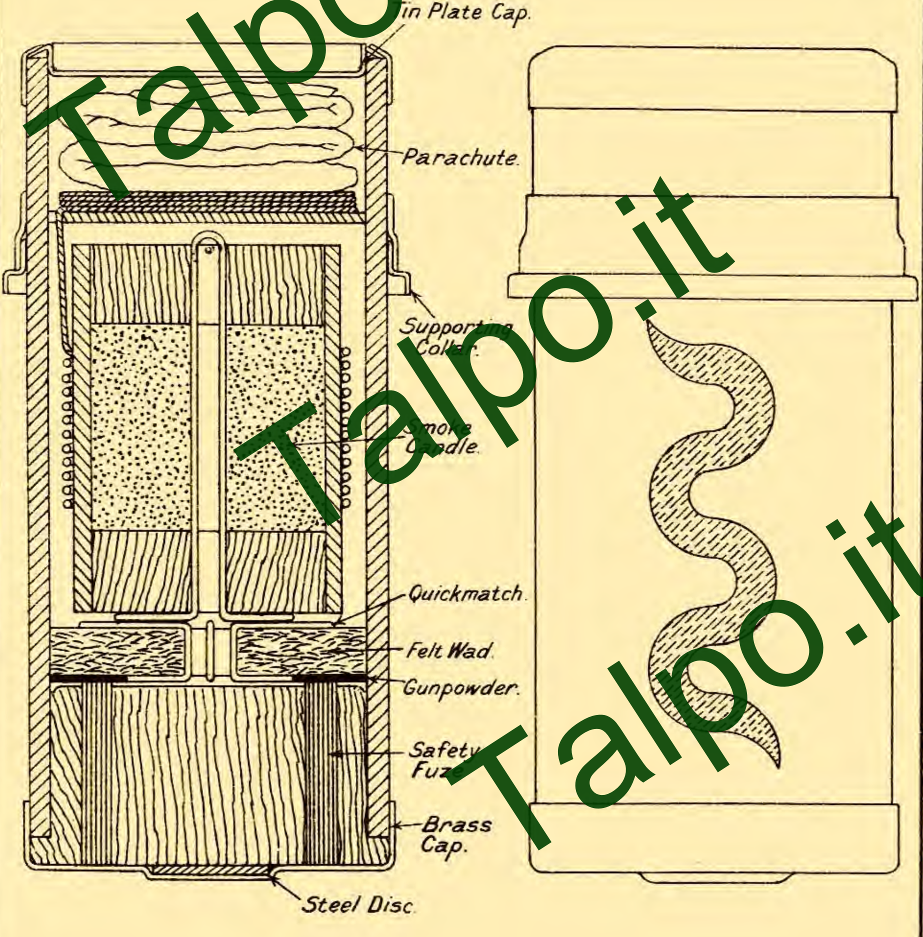
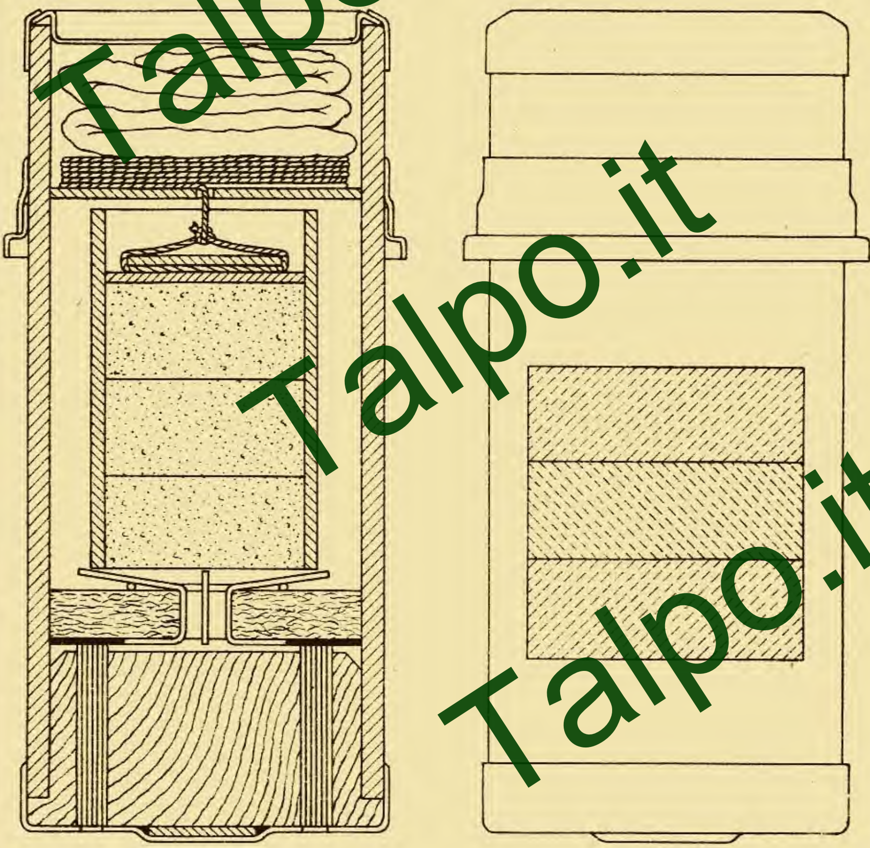


Fig. 10·06 (b).

GRENADE, SIGNAL, (NIGHT) No. 45 MARK I.



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The tube forms the seating for the detonator.

The side of the chamber is drilled to take a safety bolt. A gallery is formed round the head, which is closed by a screwed cap.

The top and bottom of the chamber are formed to provide coned seatings to the firing pellets.

The *firing mechanism* consists of a die-cast *ball* resting on the cup-shaped head of a tinned steel *striking pellet*, the lower end of which consists of a needle stem with a split point. The needle stem slides in the brass *cap pellet*, which is drilled to receive it. A seating is formed at its base end to take a percussion cap, with a hole drilled through the centre of it, which is filled with 1·2 grains of detonating composition "A" mixture. The surface is covered with shellac varnish.

The cap and needle pellets are held apart by a light creep spring.

The *creep spring* serves to keep the ball on top of the striker pellet and the rounded base of the cap pellet against the coned top and bottom seatings, respectively, in the chamber, in which these pellets are otherwise free to move.

Filling.—Baratol.

Safety arrangements.—(*a*) A steel *safety bolt* tapered at the end enters freely through a hole drilled through the stem of the striker pellet.

At its outer end it is pivoted to a metal tag, to which is attached a cotton webbing tape, which is wrapped about 2½ times round the outside of the chamber. A similar metal tag is fixed to the free end of the tape and is weighted with lead.

(*b*) A *safety cap*, which is locked on over the mechanism chamber as follows :—

Indents are punched in the safety cap, which can only be put on over the mechanism chamber past the cut-away portions round the head of the chamber. The mouth of the cap is pressed on to the rubber washer on top of the grenade body, and the cap is then twisted right-handed about one-tenth of a turn.

This causes the indents to pass under the projecting head of the chamber, so locking the cap firmly, and sealing the head of the grenade against moisture.

Arrangements to prevent tampering.—After assembly as above, a strip of tape is shellacked across the junction of the safety cap and grenade body. The grenade should retain this tape in position until immediately before it is required for throwing or firing.

Loading arrangements.—The base plug is unscrewed, to allow of the insertion of the detonator, and is then replaced. It is fitted with a small rubber pad, on which the base end of the detonator rests. A feather is formed under the plug to enable the plug to be inserted or removed when necessary, with the help of the slot in the bayonet pommel.

Action of grenade. In transport.—The pellets are held apart by the safety bolt.

Preparation for use.—Insert detonator as described above. No safety arrangement is affected by this operation.

Preparation for throwing or firing.—Grasp the bomb in the throwing hand. Grip the safety cap in the other hand. Twist the body of the grenade one-tenth of a turn anti-clockwise and then withdraw it from the cap.

The grenade is now ready to be thrown or placed base first in the discharger ready for firing.

If in doing so the grenade is dropped, the tape will not have unwound sufficiently to pull out the safety pin. The grenade therefore remains locked, the tape can be re-wound, and the grenade recovered.

Grenade in flight.—The natural gyrations of the grenade in flight cause the tape to unwind off the head rapidly and thus withdraw the safety pin.

The firing pellets are now armed, only the weak creep spring holding them apart.

Action on impact.—If the grenade falls on its—

(*a*) Head.—The cap pellet overcomes the weak creep spring by its inertia and draws its cap on to the needle of the striker pellet. The flash from the cap passes direct into the detonator immediately below the chamber.

(*b*) Base.—The inertia of the ball and striker pellet drives the needle of the latter into the cap.

(*c*) Side.—The inertia of the ball, working on the front coned end of the chamber and of the cap pellet on the rear coned end, forces the two pellets together as they slide down these surfaces, thus bringing the cap and needle together.

Transport.—Grenades travel 16 in a box, complete with a separate cylinder containing 16 grenade detonators and a tin box containing 20 rifle grenade cartridges.

The charge of the latter is 30 grains of ballistite.

Grenade, No. 54, *Mk. II*, differs from the Mk. I in having—

(*a*) an improved detonator,
(*b*) a disc on the safety cap,
(*c*) a more efficient seal between junction of cap and body,
(*d*) a needle with a single point.

Considerations affecting present grenade policy.

Although it is fully realized that the No. 36 type of grenade has certain defects, which were the reasons for the production of the No. 54 grenade, the present policy is to continue to use the No. 36, of which large stocks still exist, until such time as experiments in other directions give a somewhat clearer indication as to whether a dual purpose, *i.e.*, rifle and hand grenade, is really required.

The tube is charged with 30 grains of fulminate of mercury, it is soldered to the brass socket and the bottom is closed by a plug of shellac putty. The priming composition of guncotton dust and mealed powder surrounds a platinum silver wire bridge, and is contained in a cup, the hole being closed by a vegetable paper disc.

The connecting wires pass through the ebonite head and are soldered to the pole pieces. The ends of the connecting wires are bared, and are of unequal length to minimize the risk of a short circuit when connecting up.

A current of 1 ampere must fire the detonator, and the resistance of the bridge is to be between 1·5 to 1·8 ohms.

Marking.—The head and socket are painted *yellow* and the tube portion *red*.

Packing—The detonators are packed 25 in a tinned-plate cylinder which is painted half *yellow* and half *red*. A "rectifier guncotton primer" is also included in the tinned-plate cylinder.

Detonator, Electric, No. 13, *Mark III, is obsolescent.* It differs from the No. 9 in a few details.

Marking.—Upper half is painted *white* and the lower half *red*.

§11.13. Fuze, electric, No. 14, Mk. IV.

This fuze is used for exploding charges of gunpowder, etc.

In construction it is similar to the No. 9 detonator except that the magazine is charged with G.20 gunpowder, instead of fulminate of mercury.

Marking.—The fuze is painted *white* all over, and packed 25 in a tinned-plate cylinder which is also painted *white*.

Fig. 11·12.

DETONATOR, ELECTRIC, Nº 9, Mk IV /LA/.

Scale 1/1.

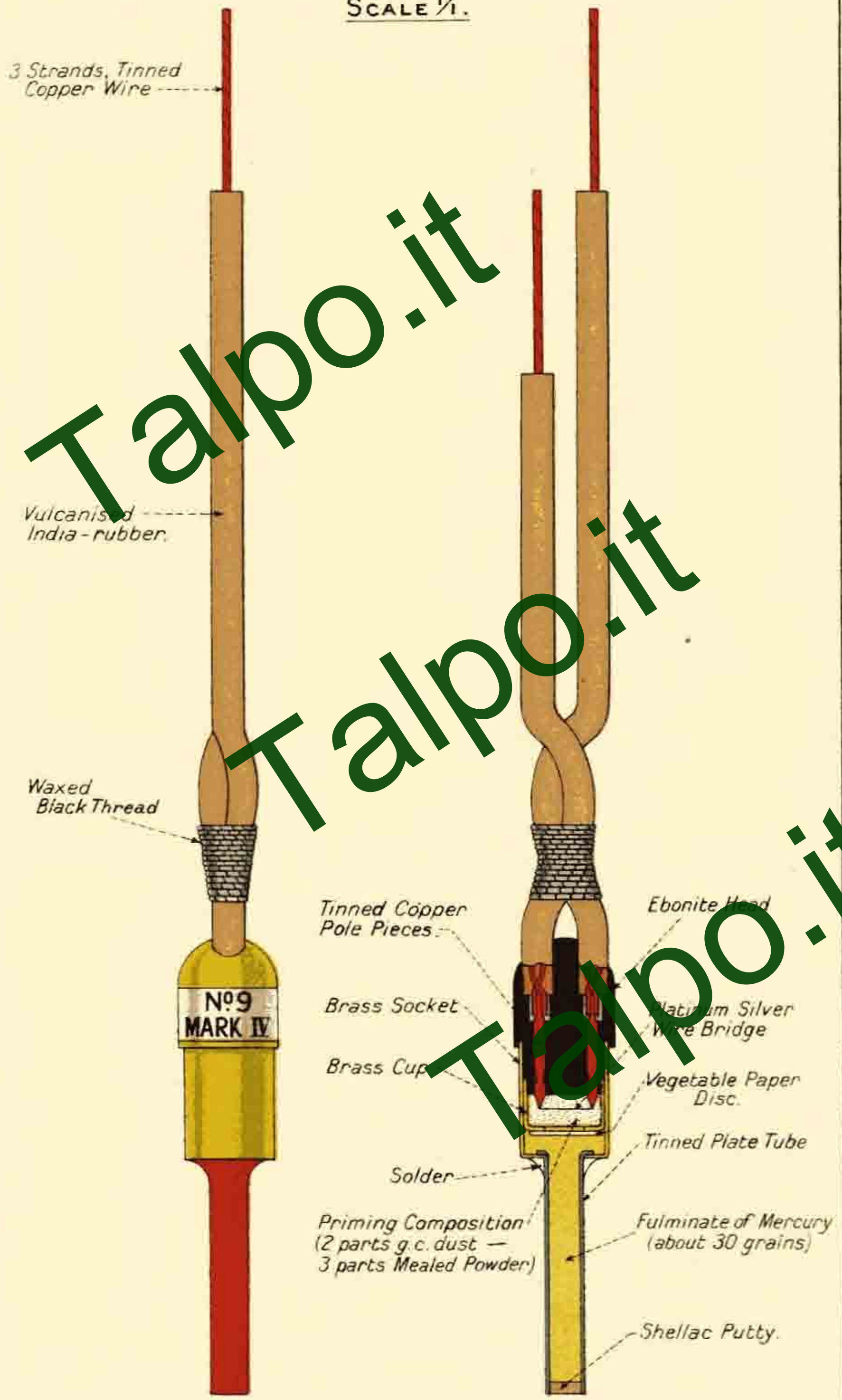

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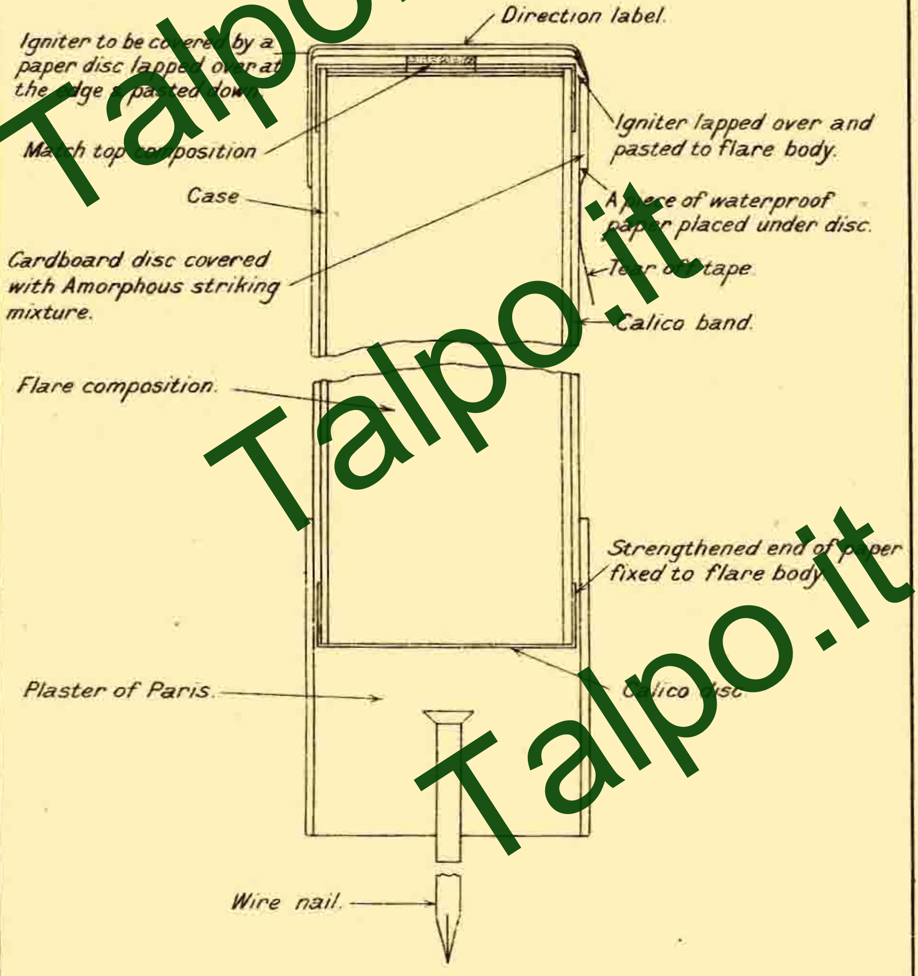
Fig. 12·10.

FLARE, GROUND, 1/2 HOUR, RED, MARK I.

Scale = 2/3.



The various flares in the land service are :—

(1) Flare, Ground, ½-hour, Red.

(2) Flares, Ground.

3 inches by 2 inches diameter, Red, Yellow, Green, White.

1¾ inches by 2 inches diameter, Red, Yellow, Green, White.

1½ inches by 1½ inches diameter, Red, Yellow, Green White.

The diagram of (1) gives the general construction of a flare.

To ignite the flare, the tear-off tape is pulled sharply upwards, thus removing the top cardboard disc and baring the igniter, which is then ignited by rubbing the amorphous phosphorus disc sharply across the match composition at the top.

The flares mentioned in (2) differ from (1) in not being fitted with the socket containing plaster of paris and the nail, and also in dimensions. Their times of burning vary from 2½ minutes to 40 seconds according to size and colour (yellow longest, red, green, and white shortest).

A paper label, of the same colour as the composition in the flare, gives the designation of the flare and instructions for use ; it is pasted on the top of each flare.

§12.11. Smoke producers.

There are two smoke producers which fall under the heading of pyrotechnics.

(*a*) *Candle, Smoke, Ground, Mk. II, Type S*1.

The candle consists of a cylindrical case of tin-plate with a spring-on lid. The case is filled with smoke composition and a friction ignition arrangement contained in a tin thimble protrudes through a hole in the lid. On a tear-off tape are fastened a tin cap which lies over and protects the friction composition in the thimble and a cardboard disc covered with striking composition. The whole is covered with a waterproof paper cover from under which the end of the tear-off tape protrudes.

To ignite the candle the tear-off tape is pulled sharply upwards, thus baring the igniter, which is fired by rubbing the striking disc firmly across the blob of friction composition. The smoke should last from 3 to 4 minutes.

This is obsolescent and is being replaced by—

(*b*) *Generator, Smoke, No.* 5, *Mk. I.*

In this generator the cylinder is made air-tight, being closed by a baffle plate. This is raised in the centre to accommodate the igniter. The raised portion is perforated and closed with a soldered tear-off plate (fitted with a D ring to assist removal). Two striker sticks are attached to the top of the baffle plate by adhesive tape and the whole is closed with a lid fastened by adhesive tape.

To fire the generator, remove the lid, put a finger through the D link and tear-off the igniter cover and strike the exposed igniter with the prepared end of one of the sticks. The smoke should last from $5\frac{3}{4}$ to 8 minutes.

§12.12. Signal, vertical light ray.

Yellow to Red, Mk. I.
Yellow to Green, Mk. I.

This store has been introduced for use by artillery survey personnel in locating survey stations. The signal consists of a tinned-plate cylinder closed at the top with a millboard and tinned-plate disc and at the bottom (ignition end) with a book-muslin disc, a perforated tin-zinc alloy disc and a red shalloon disc.

The signal is primed at the bottom and filled with yellow composition topped with red or green composition. The unit is then pressed in a floating mould to about half its original size.

A label " Yellow to Red " or " Yellow to Green " as applicable is fixed to the top.

The signal is fired vertically from the 2-inch discharger. The flash from the propellant burns through the shalloon disc and ignites the priming through the holes in the perforated disc.

The signal rises to a height of 400 to 500 feet leaving a trail of smoke and yellow flame which changes at the vertex to green or red. The yellow light lasts about 3 seconds and the second colour about 2 seconds.

§12.13. Thunderflash, Mk. I.

This consists of a cylindrical brown paper body closed at the base with a wood plug and containing a 1·8 inch length of safety fuze followed by a $\frac{3}{8}$-inch length of quick-match and surrounded by 10 grains of loose composition. The body near the top is choked to the fuze with two turns of twine and the space above the choke filled with priming and covered with a paper cap, secured with a paper band, over a tear-off tape.

A label giving the designation of the store and instructions to " Throw away immediately the friction is struck " was attached to the body of the first supplies, which were made by Brock's and provided with an igniter. In later supplies the label reads " Throw away immediately the priming is ignited."

This store, which is obsolete for future manufacture, is used for simulating gunfire for the training of horses or at displays.

Fig. 12·11 (a).

CANDLE, SMOKE, GROUND.

MARK II.
TYPE "S1."

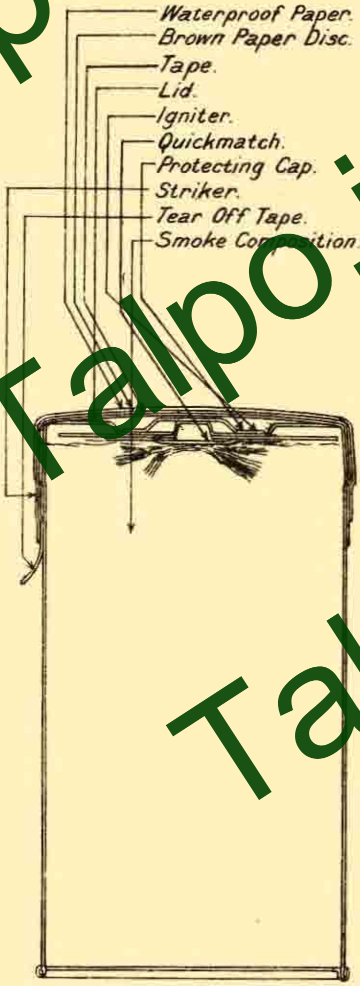


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Fig. 12·11.(b).

GENERATOR, SMOKE, No 5 Mk I.

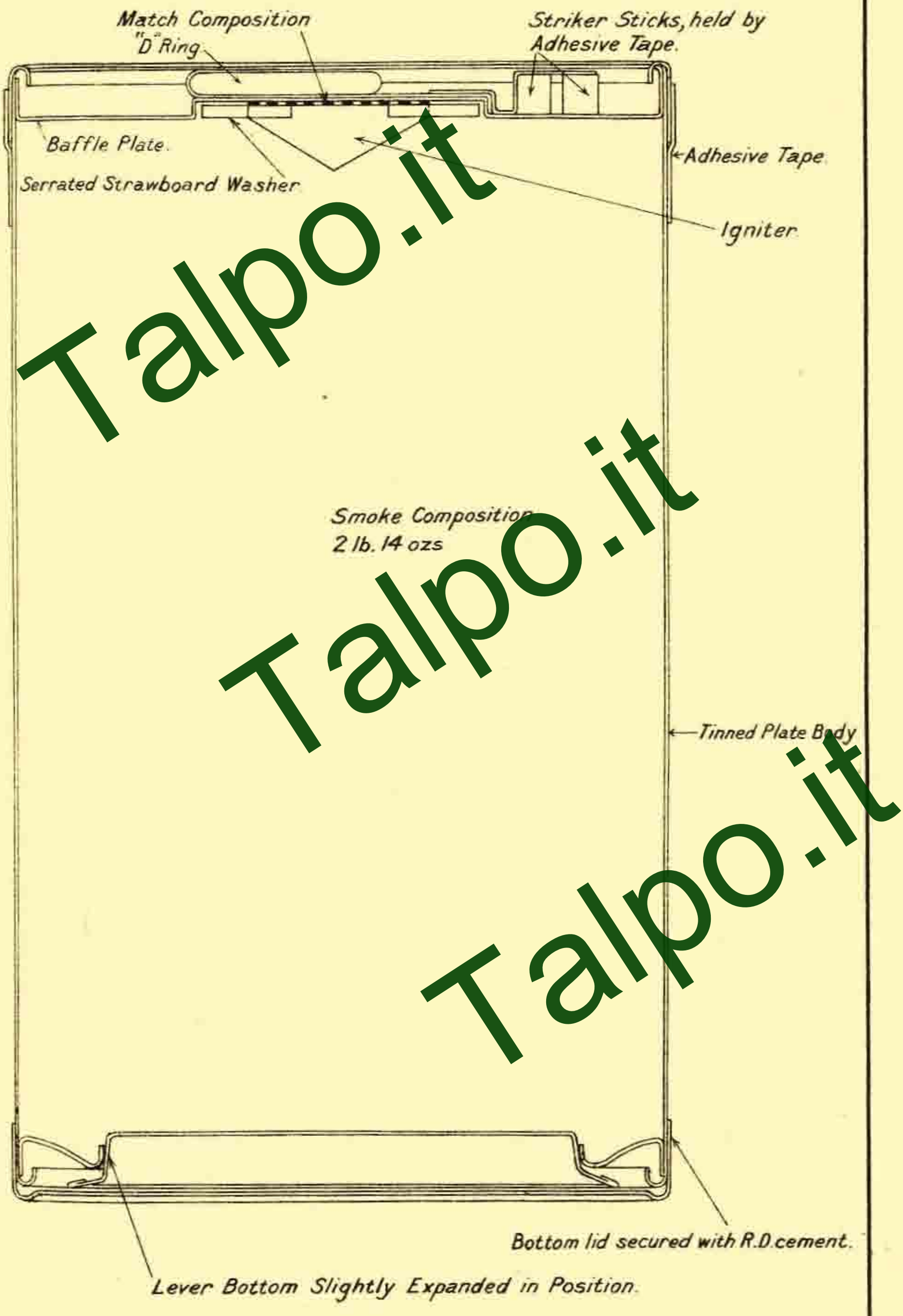

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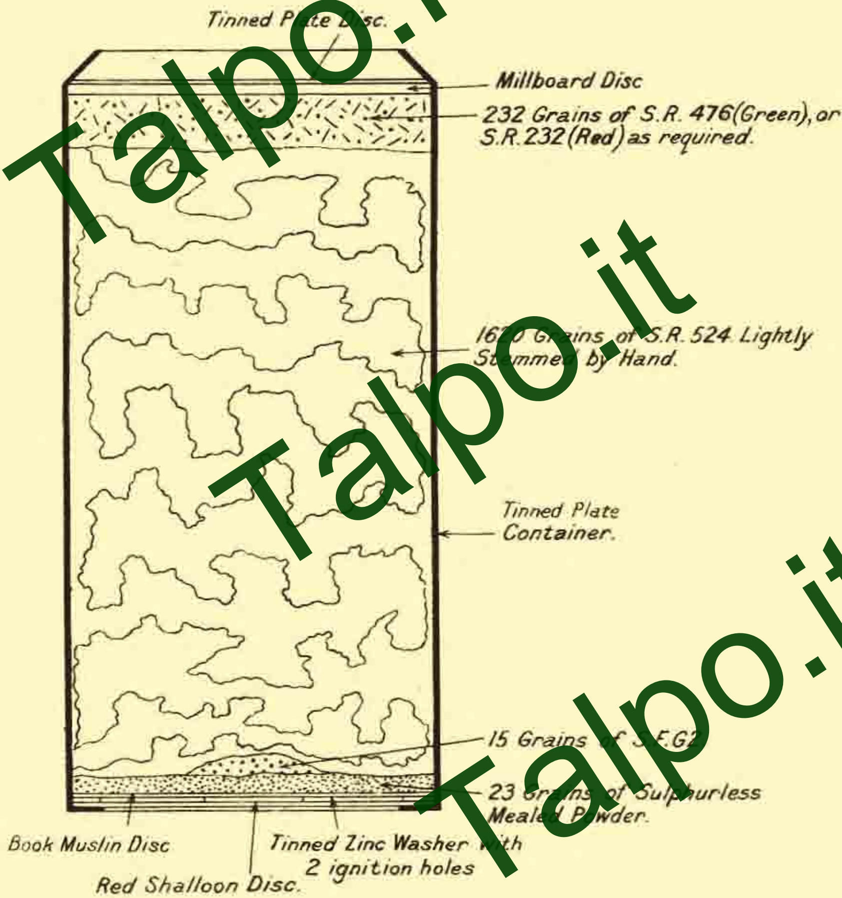
Fig 12·12.

SIGNAL VERTICAL LIGHT RAY.

YELLOW TO GREEN.
YELLOW TO RED.

DIAGRAM OF ASSEMBLY (BEFORE PRESSING)



After assembly the Signal is compressed under a load of 18 Tons. Final length about 1·65 Inches.

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